U. S. NAVY SUPPLY CORPS SCHOOL
NAVAL SUPPLY DEPOT, BAYONNE, NEW JERSEY

[redacted] OF SMALL PARTS EQUIPMENT
(STEEL WIRE PALLETS)

[redacted] 68.4190
[redacted] 15, 1947

NAVY REPORT SERIAL NT-003-010
REPORT #1

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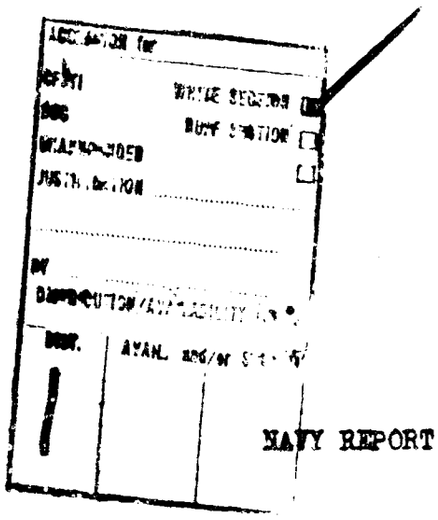

NAVY REPORT SERIAL NO. NT-003-010

REPORT NO. 1

PROJECT REPORT NO. 2.4190

"DEVELOPMENT OF SHORE ARMY EQUIPMENT"
(STEEL WIRE PALLETS)

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REPORT NO. 1

PROJECT REPORT NO. 2.4190

DEVELOPMENT OF SHORE PARTY EQUIPMENT
(STEEL WIRE PALLETS)

Authorization - Chief of the Bureau of Supplies and Accounts letter to Chief of Naval Operations, N41(PO-4)AGG, 16 Jan 47.

Purpose - The investigation and test of two designs of Steel Wire Pallets for possible acceptance as "Shore Party Equipment" to be used in amphibious Navy Combat supply.

Conclusions - Final results of all tests included in the Navy Standard Test Procedure For Pallets indicate only limited acceptability of the Steel Wire Pallet (Rolled Expanded Metal Deck) for Shore Party Equipment use in combat supply.

The Steel Wire Pallet (Fibreboard Deck) was proven by the same tests to be impractical and not acceptable for combat supply due primarily to breakage of the deck under normal operating conditions.

The Steel Wire Pallet (Rolled Expanded Metal Deck) was found to be not satisfactory for a number of characteristics which are considered to be of utmost importance in amphibious combat operations. The chief of these is Test #11, Movement Test. In some instances it may be necessary to make movements of pallets

by emergency means when regular handling equipment is damaged or not available. Such movements cannot readily and easily be made with the present design of the tested steel wire pallets. Other major points wherein the Steel Wire Pallet (Rolled Expanded Metal Deck) is not satisfactory are the "Non-suitability for tiering of bagged goods" and for, "Reassembly." Other unsatisfactory characteristics are of a comparatively minor nature when considered for combat work or are such that these deficiencies may be easily corrected.

A short summary of test conclusions is as follows: Results for the Standard Navy Wood Pallet are also included as a basis for comparison.

SUMMARY OF TEST RESULTS

	Steel Wire Pallet (Rolled Expanded Metal Deck)	Steel Wire Pallet (Fibreboard Deck)	Standard Navy Wood Pallet
1. Weight Determination (48"x48")	66 3/4 lbs	53½ lbs	90 to 120 lbs
2. Load Capacity (Minimum Standard)	Satisfactory	Not satisfactory	Satisfactory
3. Tiering Ability	Satisfactory-Not for bagged goods	Satisfactory-Not for bagged goods	Satisfactory
Percentage of Bottom Area Top. Dimensions	21% (Not entirely suitable)	21% (Not entirely suitable)	59% Satisfactory.
4. Suitability for Bagged Goods	Not suitable	Not suitable	Satisfactory
5. Overload Test (40,000 lbs)	Failure	Failure	Satisfactory
6. Shock Loading	Satisfactory	Not suitable	Satisfactory
7. Towing Test Unsupported	Satisfactory (Conditional)	Satisfactory (Conditional)	Not satisfactory.
8. Toboggan Towing Suitability Test	Satisfactory (Could be imprvd)	Satisfactory (Could be improved)	Satisfactory
9. Assembly Strength Test	Satisfactory	Not suitable	Satisfactory
10. Racking Test	Satisfactory	Not suitable	Not satisfactory.
11. Movement Test			
By Roller Conveyor	Not Satisfactory	Not Satisfactory	Satisfactory
By Roller Bars	Not Satisfactory	Not Satisfactory	Satisfactory
By Skids	Not Satisfactory	Not Satisfactory	Satisfactory
12. Water Absorption & Retention	Satisfactory	Satisfactory	Not Satisfactory
13. Test for Protective Coatings	Not Satisfactory	Not Satisfactory	None
14. Oil Absorption Test	Satisfactory	Satisfactory	Not Satisfactory
15. Fire Resistance	Satisfactory	Satisfactory	Somewhat resistant.

16. Sweat Resistance	Satisfactory	Satisfactory	Satisfactory
17. Percentage of top area	36%	100%	84%
. Coefficient of Static Friction	Wood .55 Carton .73	.57 .59	.44 .32
. Coefficient of Sliding Friction	Wood .42 Carton .65	.46 .59	.39 .34
. Glue Loading	Satisfactory (Conditional)	Satisfactory	Satisfactory
18. Suitability for Steel Strapping	Satisfactory	Satisfactory	Satisfactory
19. Suitability for Stevedoring Operations:			
Drop Test	Satisfactory	Not satisfactory	Satisfactory
Smash Test	Satisfactory	Not Satisfactory	Satisfactory
Ship Conveyor Loading Systems	Satisfactory	Satisfactory	Satisfactory
20. Entrance Possibilities	8 way Satisfactory	8 way Satisfactory	2 way - Not Satisfactory
21. Clearance Allowance for Lift Trucks	Satisfactory	Satisfactory	Satisfactory
22. Pick Up Test:			
By Fork Truck	8 way Satisfactory	8 way Satisfactory	2 way only
By Hand Truck	2 way only (can be corrected to 4 way)	2 way only (can be corrected to 4 way)	2 way only
23. Provision for Repair	Not satisfactory	Not satisfactory	Satisfactory
24. Nesting & Dunnage Capacity	Not entirely satisfactory	Not entirely satisfactory	Not entirely satisfactory
25. Freight Humping Suitability	Not satisfactory	Not satisfactory	Satisfactory
26. Pallet Adaptability	Partially satisfactory	Partially satisfactory	Very satisfactory
27. Buoyancy Test	Sinks	Sinks	Floats
28. Sparking Test	Sparks	Sparks	Nails spark
29. Reassembly Test	Not satisfactory	Not satisfactory	Satisfactory
30. Unit Cost	$12.00	$12.00 Std.Stk.Cat. Pres.day- Oct.1947	$2.30 3.10

RECOMMENDATIONS

It is believed that the subject matter and photographs of this report on Steel Wire Pallets will prove of inestimable value to Naval Officers, Naval Civilians and to designers and manufacturers of all pallets, since for the first time a comprehensive list of necessary Naval Pallet characteristics are presented with actual evidence of the satisfactory meeting or non-meeting of such requirements for two sample types of pallets.

Present data urges the retention of the rolled expanded metal decking for pallets due to the great strength characteristics which are inherent in such design with a minimum amount of weight. Although such deck is not ideally suited for glued unit loads, the many other advantages of this deck overshadow the one defect. The present detraction of the Steel Wire Pallet (Rolled Expanded Metal Deck) lies in the design of its bottom steel wire structure which is subject to damage by concentrated loads and by certain shearing forces. Insufficient bearing surface on the bottom of the pallet also affects its usefulness.

The major advantage of this pallet over the Standard Navy Wood pallet lies in its comparative light weight and the fact that it has entrance possibilities of 4 to 8 ways instead of the two ways of the wood pallet.

The Steel Wire Pallet (Rolled Expanded Metal Deck) is recommended for limited adaptability for use in amphibious combat supply. It is capable of improved design and lacks meeting of certain key characteristics which prohibit complete approval for intended usage. Careful study of test results will indicate wherein improved

design is necessary. Definite recommendations for any particular design of pallet for amphibious combat service, is not being made at the present time, pending completion of tests now underway on all types of pallets under Navy Report Serial No. MT-003-004, entitled, "Pallets, New Developments."

The Steel Wire Pallet (Fibreboard Deck) is not recommended for combat usage due to structural defect in the decking which is of insufficient strength to withstand combat handling.

It is recommended that additional developmental work be accomplished in the search for pallets to be used for amphibious combat purposes.

COMPILATION OF TEST RESULTS

INDEX

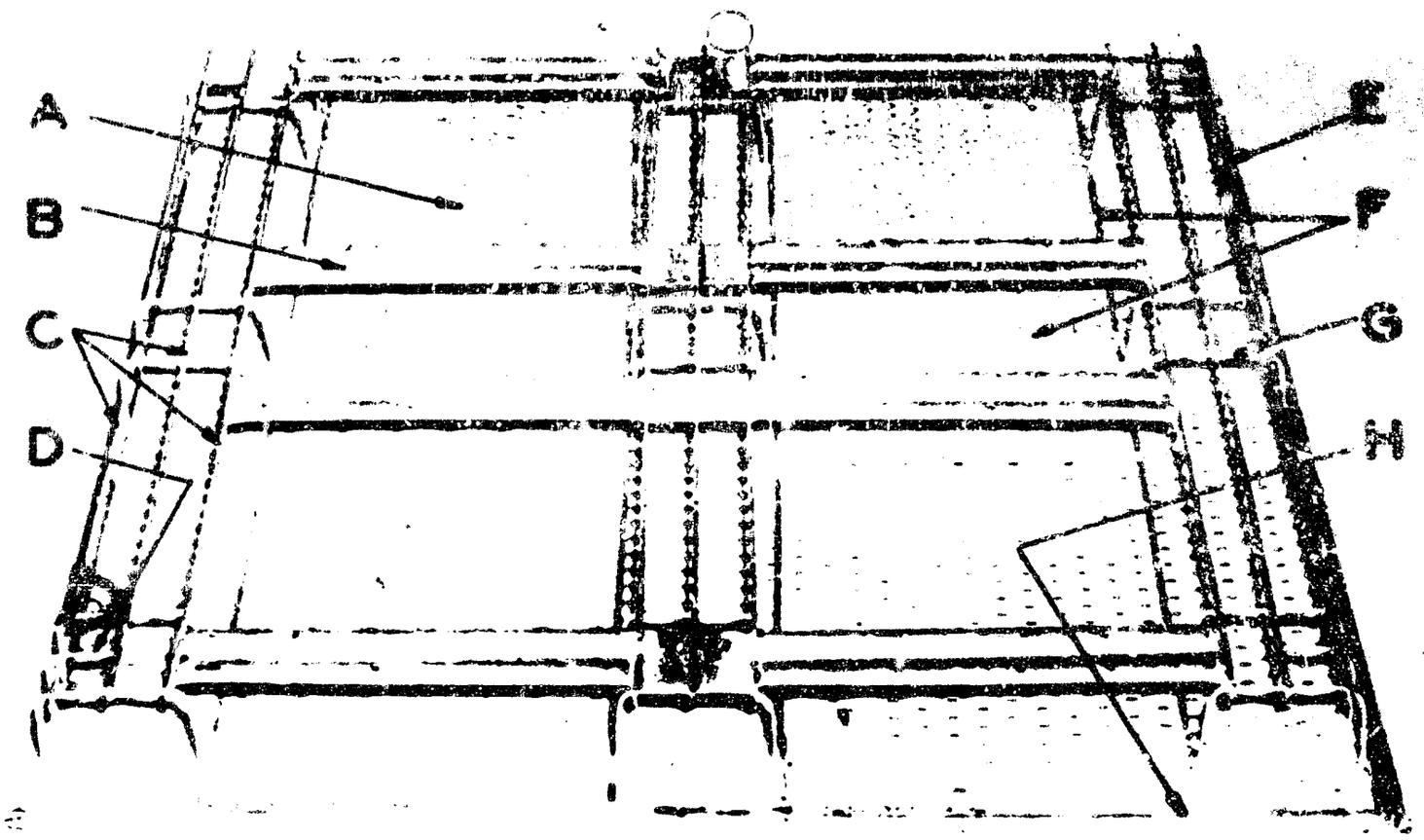
PREFACE:

Each of the two types of pallets were tested in accordance with the "Navy Standard Test Procedure for Pallets." Additional and extended tests were instituted on towing and dragging characteristics for the purpose of this investigation.

Both types of pallets which were tested were of a steel wire fabricated design manufactured by the Tri-State Engineering Company of Washington, Pennsylvania. The bottom structure of both types of pallets were almost identical. The main difference being in the pallet tops, one of these being of a rolled expanded steel type of construction, which, for purposes of identification has been designated as a "Steel Wire Pallet (Rolled Expanded Metal Deck)." The other design of pallet has a fibreboard deck. This pallet has been designated for purposes of identification as a "Steel Wire Pallet (Fibreboard Deck)."

As a basis for comparison, a "Standard Navy Hard Wood Pallet" assembled with drive screw nails was given identical tests to the two steel wire pallets in such cases as it was believed such comparison was desirable.

Detailed descriptions of the Steel Wire Pallets tested are as follows:



MATERIAL LIST

Piece	Description	No. Req'd.
A	Rolled Expanded Metal Deck	1
B	1/8" Thick 3" Wide Ribbed Bearing Plate	4
C	.264" Dia. Longitudinal Bearing Wire	9
D	.310" Dia. "L" Shaped Vertical Wire	4
E	1/16" Thick 1" Steel "U" Edging	4
F	.264" Dia. Deck Support Wire	8
G	.310 Dia. "U" Shaped Vertical Wire	18
H	.310" Dia. Deck Extension Support Wire	2

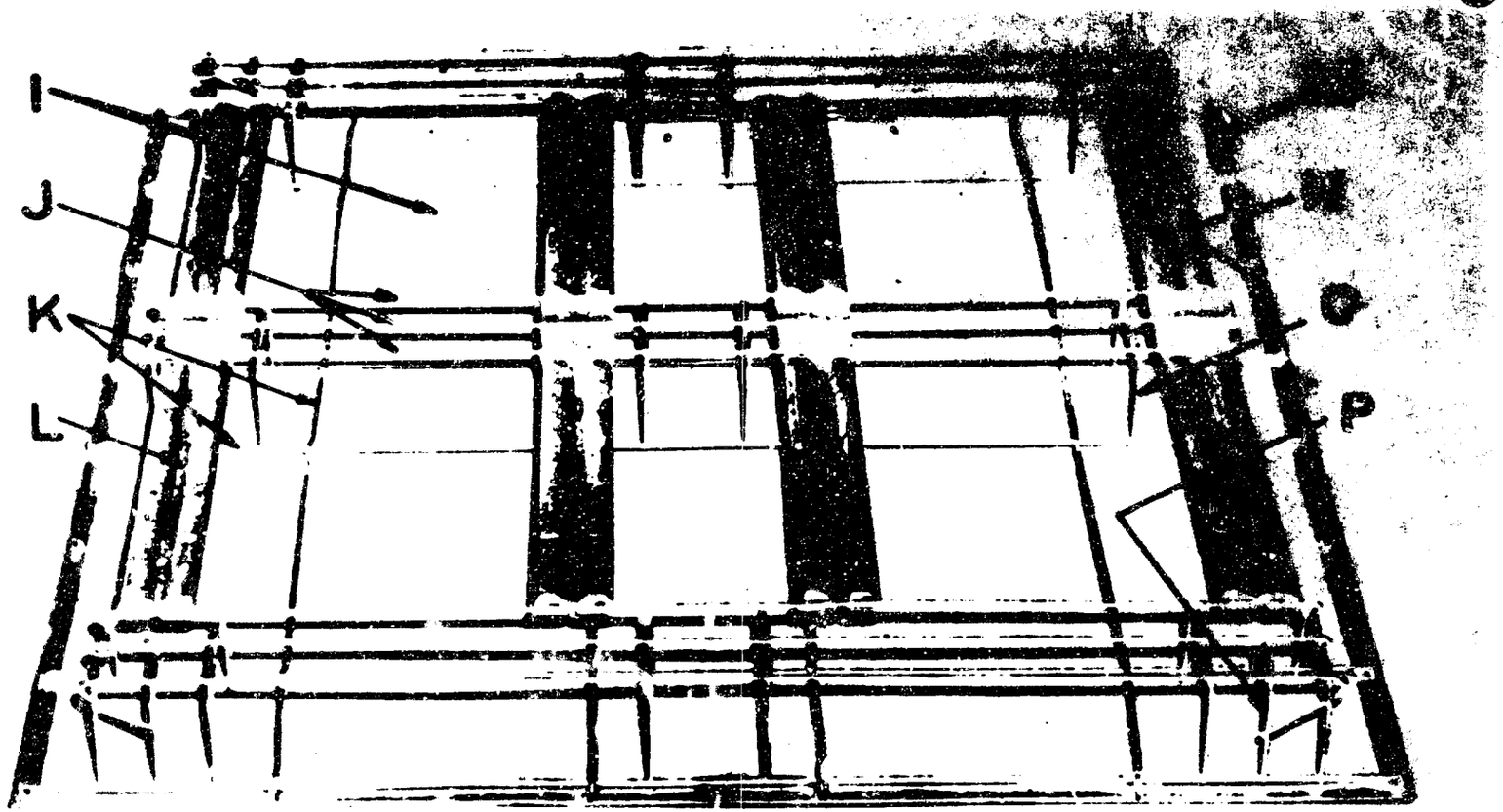
STEEL WIRE PALLET(ROLLED EXPANDED METAL DECK)

IDENTIFICATION OF COMPONENT PARTS

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-40 PAGE 10

Steel Wire Pallet (Rolled Expanded Metal Deck)

This pallet with complete Material List is indicated on Photo 67-40, Page 10. The deck of this pallet is a flattened expanded metal diamond mesh (Piece #A) and is bordered with a 1" "U" edging of 1/16" thick steel plate (Piece #E). The diamond mesh design measures 9/16" on the width and 1 3/4" along the long opening with a metal width of 1/8" and a thickness of .260". The deck is electrically welded to a series of steel wire supports .264" dia. and .310" dia. (pieces #F and H). The .310" dia. wire (piece H) is welded on the 1" "U" edging (piece E) at the sides of the 3" overhang of the top deck. Placed parallel to these wires and spaced 8" apart at the center of the deck are two .264" dia. wires (piece F). The deck is additionally reinforced by six .264" dia. wires (piece F) placed across the bottom of the deck in the opposite direction. The deck is supported vertically by groups of .310" dia. "U" shaped wires, 4" wide (piece G) and .310" dia. "L" shaped wires, 2" wide (Piece D) which are welded to the sides of the .264" dia. deck support wires (Piece F). A group of two "U" shaped and one "L" shaped wires comprise the four corner posts of the pallet with five sets of two "U" shaped wires completing the remaining vertical post supports on the center lines of the pallet. The longitudinal bearing members, (Piece C) comprise a group of three .264" dia. wires spaced 20" on centers. The transverse compression members are ribbed formed 1/8" thick by 3" wide steel plates (Piece B), four in number and placed on alternate centers of 15" and 9". The entire construction is bonded together by 1/4" resistance welds and finished with a sprayed protective coating of aluminum paint. The pallet has an overall height of 4 3/4" and 3 3/8" minimum space between deck and base members. The deck dimensions are 48" x 48".



MATERIAL LIST

Piece	Description	No. Req'd.
I	Fibreboard Deck	1
J	.264" Dia. Longitudinal Bearing Wire	9
K	.264" Dia. Deck Support Wire	10
L	1/8" Thick 3" Wide Ribbed Bearing Plate	4
M	1/16" Thick 1" "U" Steel Edging	4
N	.310" Dia. Deck Extension Support Wire	2
O	.264" Dia. "U" Shaped Vertical Wire	16
P	.264" Dia. "L" Shaped Vertical Wire	4

STEEL WIRE PALLET (FIBREBOARD DECK)

IDENTIFICATION OF COMPONENT PARTS

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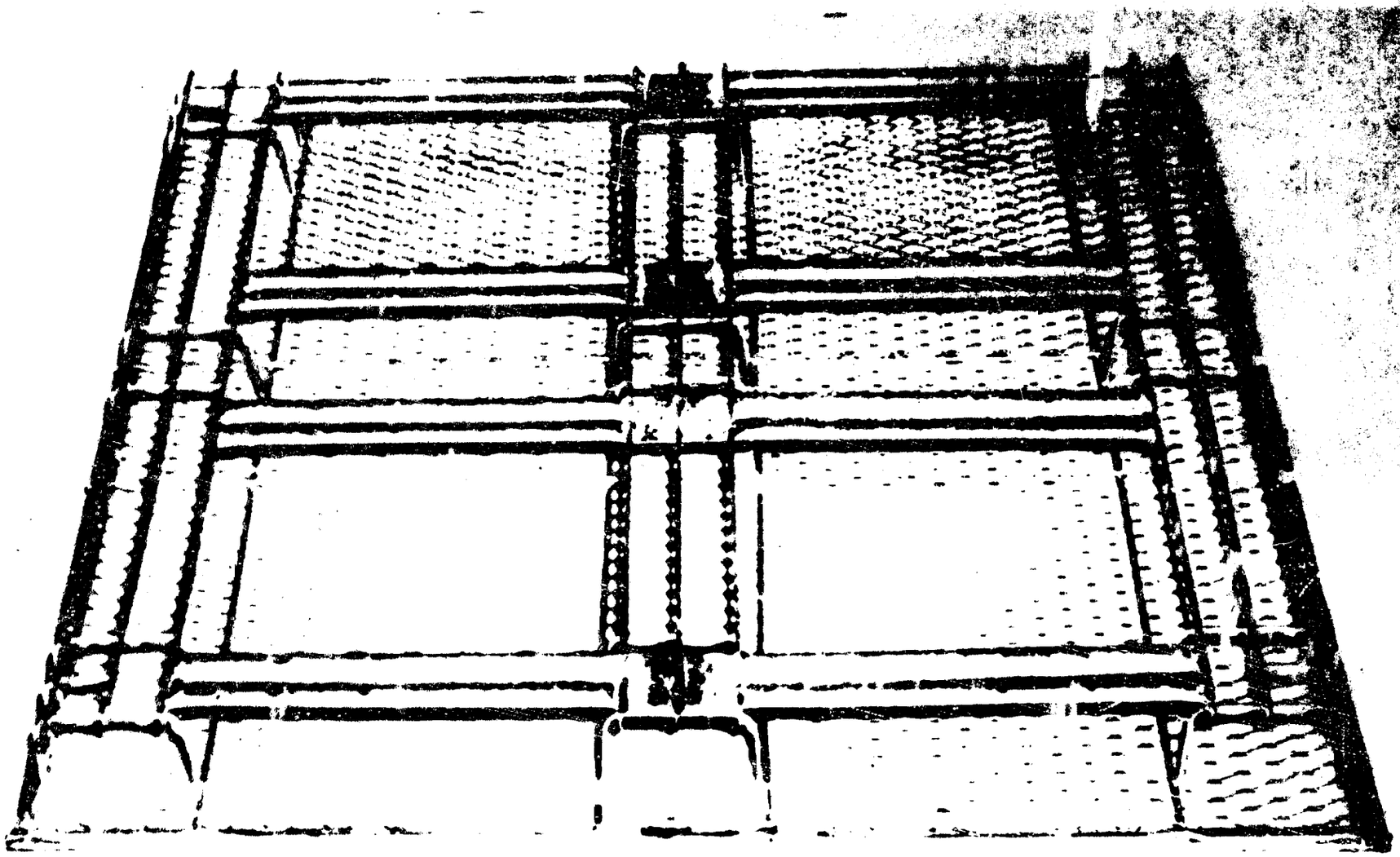
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-43 PAGE 12

Steel Wire Pallet (Fibreboard Deck):

This pallet with complete Material List is indicated on Photo 67-43, Page 12. The top of this pallet consists of a solid 48" x 48" sheet of fibreboard, .142" thick (Piece I). This sheet is bordered with a 1" "U" edging of 1/16" thick steel plate (Piece M). The deck, through the medium of the steel edging (Piece I) is electrically spot welded to a series of steel wire supports, .264" dia. and .310" dia. wires. The .310" dia. wire (Piece N) is welded on the "U" edging at the sides of the 3" overhang of the top deck. Placed parallel to these wires and spaced on alternate center distances of 11" and 8" are four .264 dia. wires (Piece K). The deck is additionally reinforced by six .264" dia. wires (Piece K) placed across the bottom of the deck in the opposite direction. The deck is supported vertically by groups of .264" dia. "U" shaped wires, 4" wide (Piece O) and .264 dia. "L" shaped wires, 2" wide (Piece P) which are welded to the sides of the .264 dia. deck support wires (Piece K). A group of two "U" shaped and one "L" shaped wires comprise the four corner posts of the pallet with five sets of two "U" shaped wires completing the remaining vertical post supports on the centerlines of the pallet. The longitudinal bearing members (Piece I) comprise a group of three wires .264" dia. spaced to a width of 4". Three such groups are then spaced 20" on centers. The transverse bearing members are ribbed formed 1/8" thick by 3" wide steel plate (Piece L), 4 in number and are spaced on alternate center distances of 15" and 9". The entire construction is fastened together by 1/4" resistance welds and is finished with a sprayed protective coating of aluminum paint. The pallet has an overall height of 4 3/4" and 3 3/8" minimum space between deck and base members.



STEEL WIRE PALLET (EXPANDED METAL DECK)

BOTTOM CONSTRUCTION

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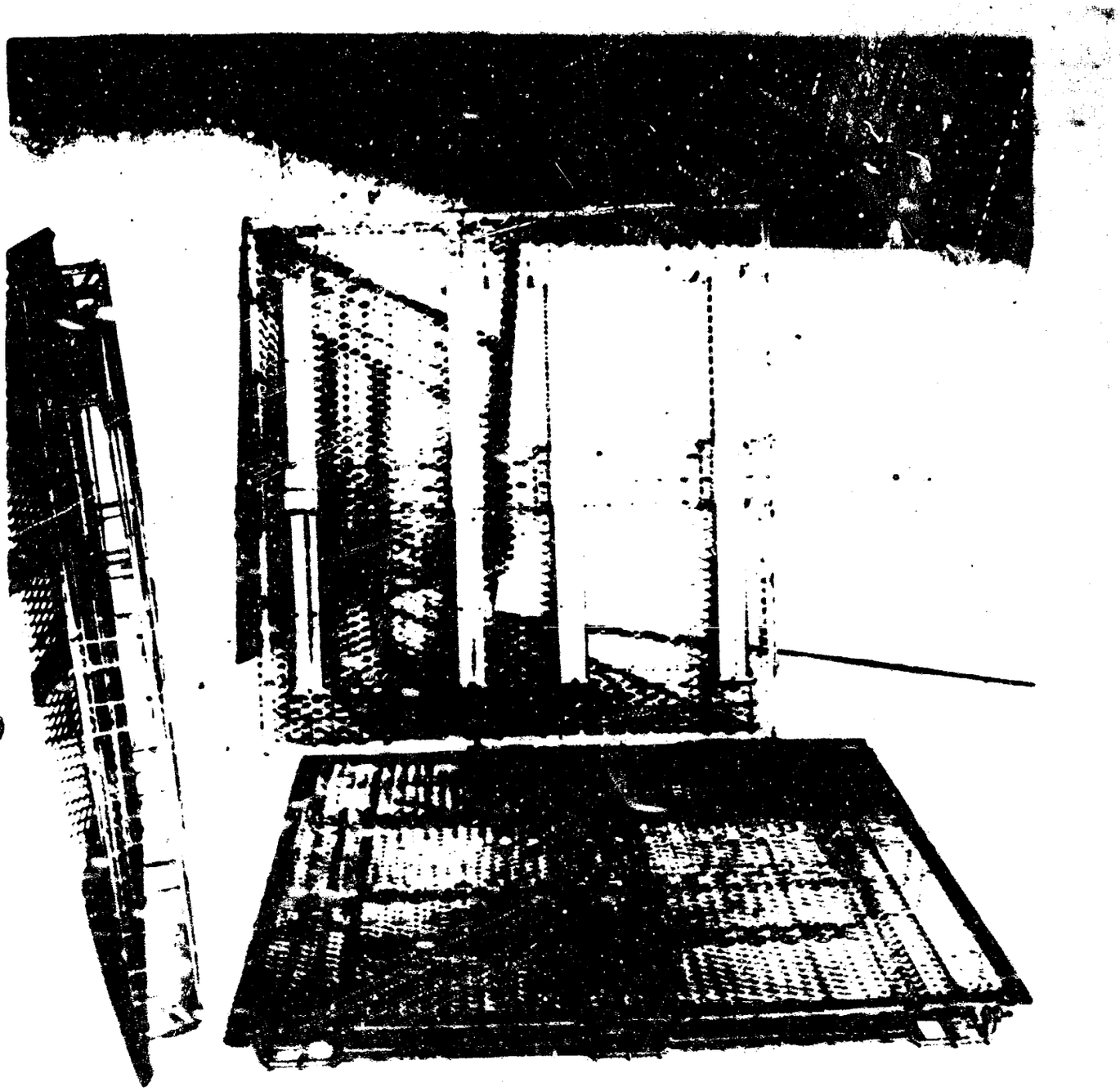
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-40-A PAGE 14



STEEL WIRE PALLET
(EXPANDED METAL DECK)
TOP, BOTTOM & SIDE VIEWS.

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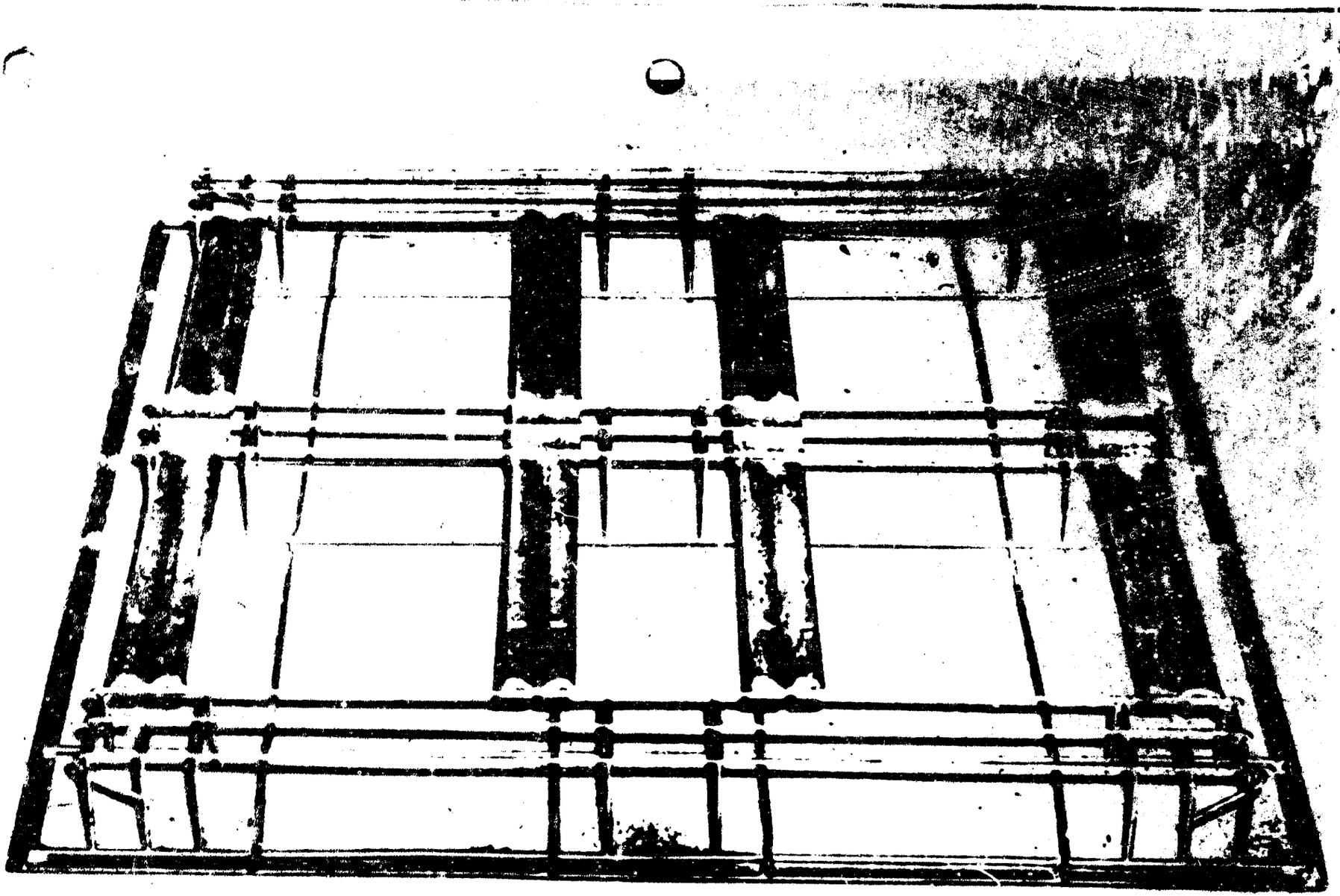
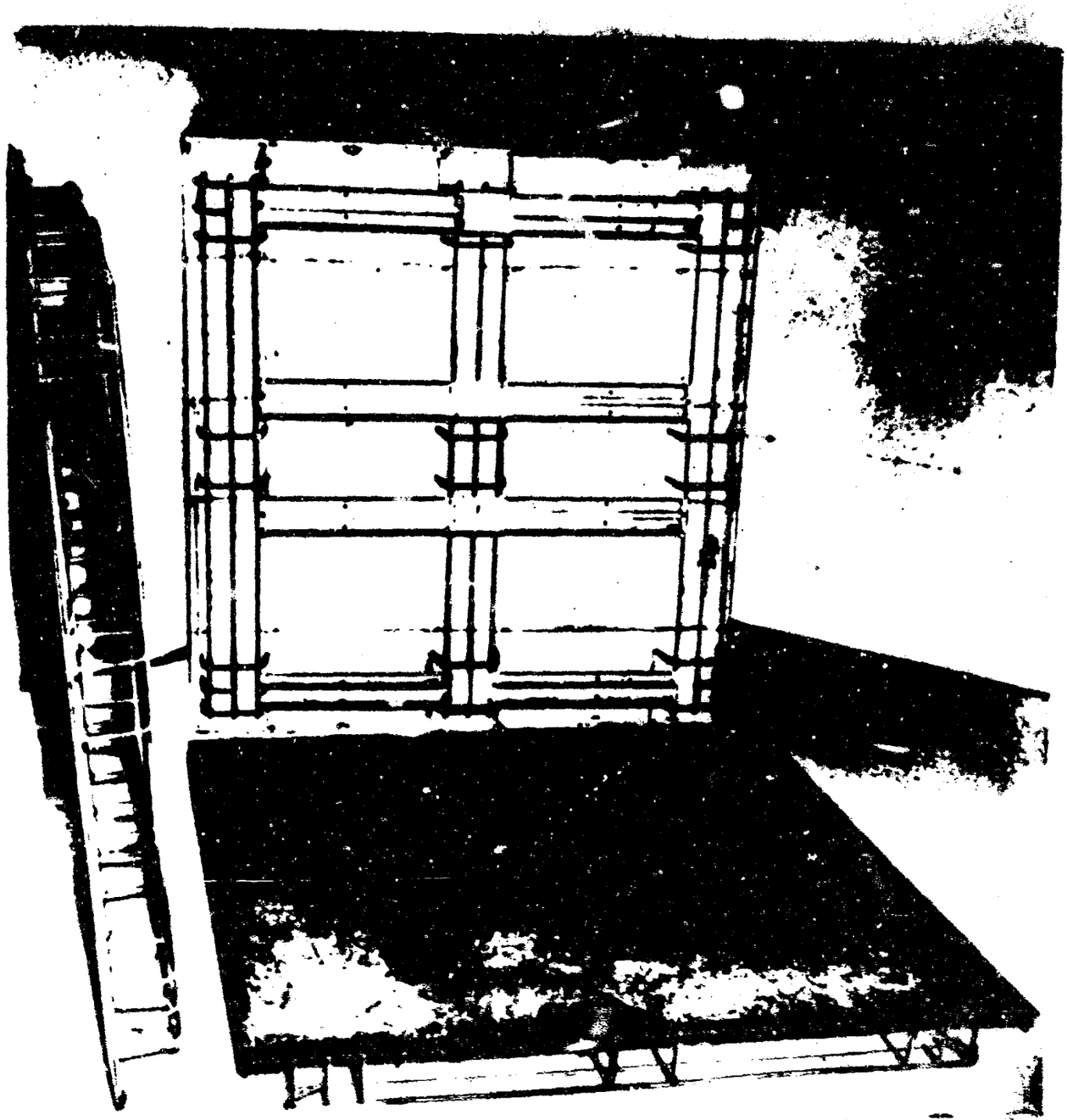
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 57-36 PAGE 15



STEEL WIRE PALLET (FINNBOARD DECK)

BOTTOM CONSTRUCTION

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-43-4 PAGE 16



STEEL WIRE PALLET
(PLYWOOD DECK)
TOP, BOTTOM & SIDE VIEWS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-39 PAGE 17

PALLET STANDARD TEST PROCEDURE RESULTS

TEST #1 - WEIGHT DETERMINATION

STANDARD TEST PROCEDURE

Each complete pallet is to be weighed and any characteristics pertaining to ease in handling are to be noted.

The weight of a pallet is particularly important since the movement of the pallet weight by railroad is charged for at the same commodity rates as the material being carried by the pallet. Weight must also be considered when empty pallets must be shipped back to the original supplier.

Weight is also important from a personnel standpoint. It is frequently necessary to handle pallets manually and it is difficult for one man to readily handle a pallet weighing more than 60 pounds. In some instances there are labor union regulations which limit the weight one man can lift to that value. Pallets weighing more than this amount will therefore require the use of two men with consequent inefficiencies and increased costs.

TEST CONDITIONS

Pallets were weighed upon receipt on a "Fairbanks 500 Pound Capacity Platform Scale." Each pallet weighed was of the 48" x 48" size.

RESULTS

Weights of pallets under test were found to be as follows:

Steel Wire Pallet (Fibreboard Deck) - - - - - 53½ lbs.

Steel Wire Pallet (Rolled Expanded Metal Deck) - - - - - 63 3/4 lbs.

U.S. Navy Standard Navy Wood Pallet - - - 90 to 120 lbs

CONCLUSIONS

The Steel Wire Pallets indicate minimum savings of 36 3/4 and 23½ pounds over the U. S. Navy Standard Wood Pallet. Although the Steel Wire Pallet (Rolled Expanded Metal Deck) weighing a total of 66 3/4 lbs does not quite meet the suggested Navy minimum desired weight of 60 lbs, it is difficult to see how redesign could be effected upon such a pallet without seriously affecting the present strength. This pallet was found to possess toughness and resiliency, and adequately protected its load. Any strength reduction to accomplish further decrease in weight would be undesirable.

TEST #2 - LOAD CAPACITY (MINIMUM STANDARD)

STANDARD TEST PROCEDURE

Each pallet will be tested under a minimum load of 14,000 pounds under static warehousing conditions for a period of at least one month, except for such pallets as are obviously designed for light materials, such as corrugated paper pallets. In such cases, the manufacturers recommendations in regard to loads suitable for one month's warehouse storage will be tested, noted and reported upon. Pallets are to be commented upon. A minimum of two pallets of every type will be tested simultaneously by stacking them one on top of the other so that satisfactory tiering conditions can also be observed (See Test #3).

A load test of 14,000 pounds has been selected as a standard test load in accordance with the following reasoning: 2,500 pounds is the load generally handled on pallets and ordinarily pallets are not tiered more than four high for warehouse storage when so loaded. Therefore, the bottom pallet is subjected to a load of 10,000 pounds due to four loaded pallets. The additional 4,000 pounds has been allowed as a safety factor.

TEST CONDITIONS

A pallet tier was formed for preliminary purposes as indicated by Photo Negative #2041 Page 21 with a total load of 9010 lbs. instead of the recommended 14,000 lbs. This load was secured on the bottom pallet by a four high tier using 100 lb. bags of sugar and crated vegetable shortening for the load. This was a

GENERAL TEST CONDITIONS OF TEST# 2- LOAD CAPACITY, TAST# 3- TIERING ABILITY & TEST# 4- SUITABILITY FOR BAGGED GOODS.

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PHOTO NEG NO 28-1 PAGE 31

static warehouse test and the tier was inspected weekly for a period of one month. At the end of one month the tier was broken down, the loads removed, and the pallets observed for possible changes.

The pallets were tiered as follows from bottom to top:

Pallet #1 (Bottom Pallet) - Steel Wire Pallet (Rolled Expanded Metal Deck). Loaded with 100# bags of sugar. Total load on pallet - 9013 lbs.

Pallet #2 - Steel Wire Pallet (Fibreboard Deck) Loaded with 100# bags of sugar. Total load on pallet - 7860 lbs.

Pallet #3 - Steel Wire Pallet (Rolled Expanded Metal Deck). Loaded with crated vegetable shortening. Total load on pallet - 4693 lbs.

Pallet #4 - Steel Wire Pallet (Fibreboard Deck) - Loaded with crated vegetable shortening. Total load on pallet - 2360 lbs.

Upon completion of the tests using a total load of 9013 lbs. the pallets were loaded with a uniform crated load of wood boxed edge protectors and a final load of 15,176 lbs. was obtained on each pallet. The boxed edge protectors were loaded 12 to a pallet and the tier was 6 high. Each box weighed 208 lbs. These tiers were permitted to stand for one months time and were then taken down and the pallets were closely inspected.

TEST RESULTS

The Steel Wire Pallet (Rolled Expanded Metal Deck), Pallet #1 in the tier, shown as the bottom pallet of Photo Negative 28-1, Page 21, and subjected to a load of 9013 lbs. showed no deformation of pallet construction after a one month period of static warehouse storage. This pallet maintained its original strength and its physical shape during all phases of this test.

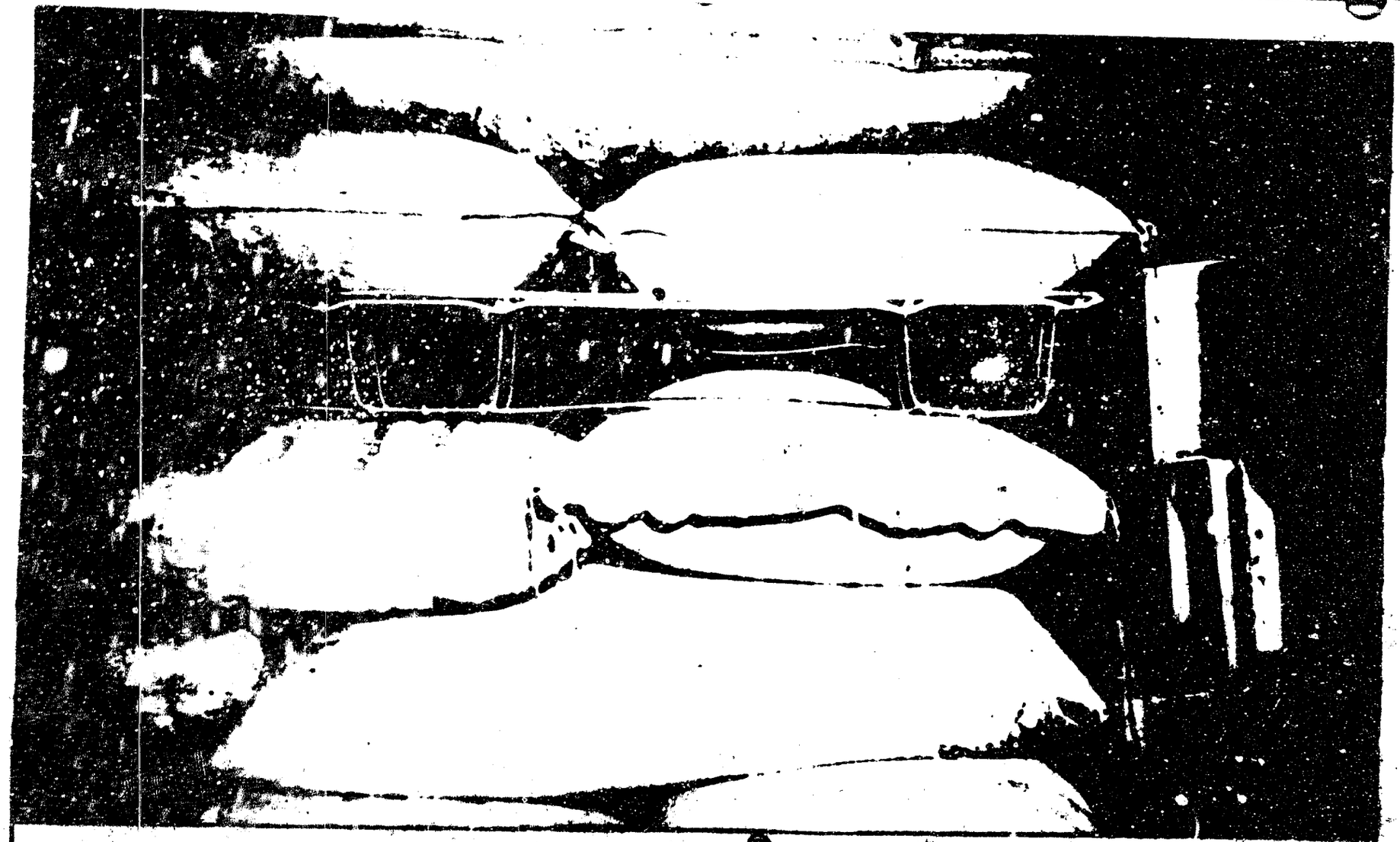

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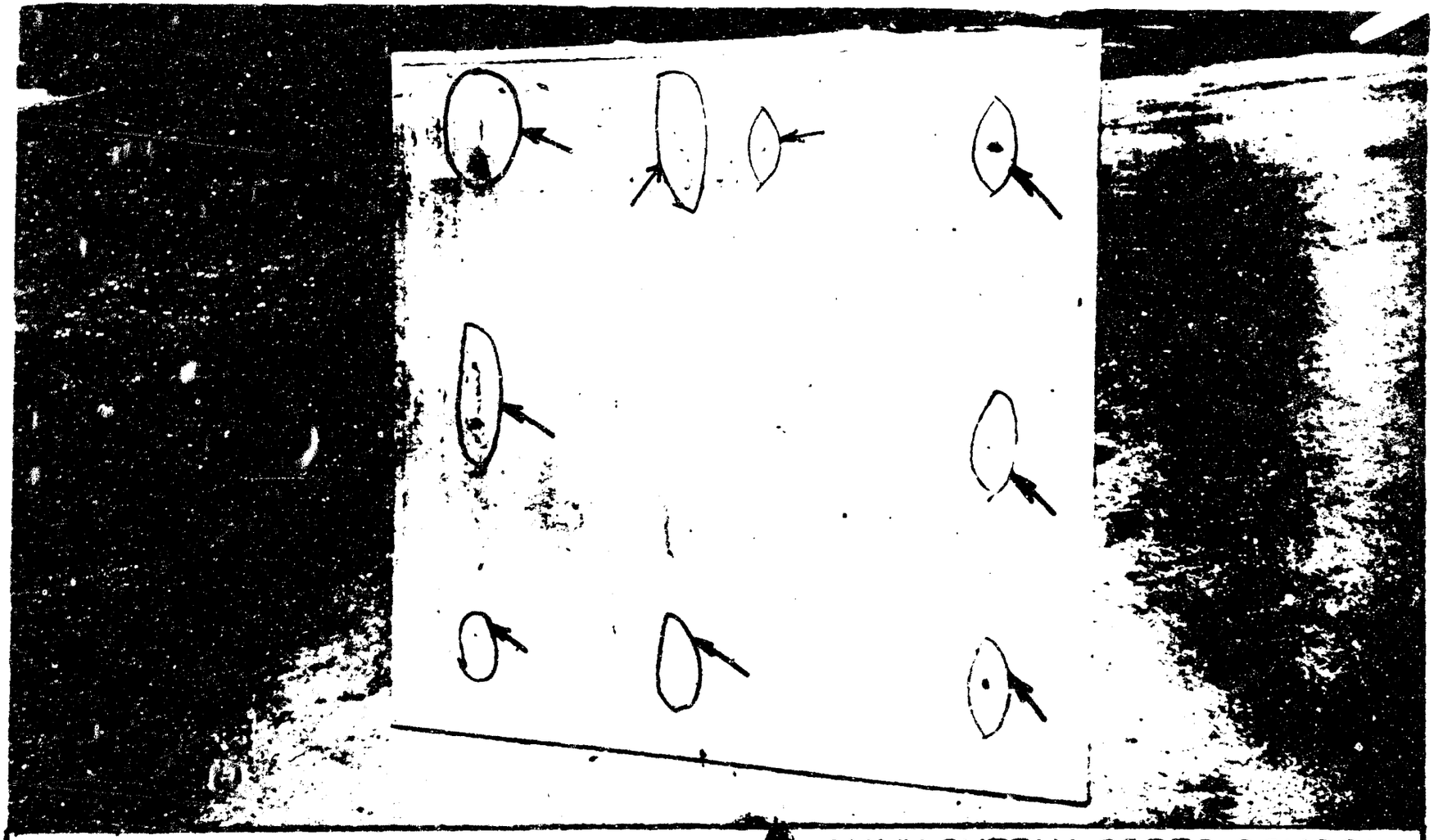
PHOTO NEG. NO. 20-7 PAGE 37

The Steel Wire Pallet, Fibreboard Deck, the second pallet from the bottom of the tier, rested on top of a pallet load of bagged sugar. This pallet showed deflections of both top and bottom wires as indicated in Photo Negative #28-7, Page 23. This deflection appeared during initial tiering operations. The horizontal .264" diameter wires on both the deck and the bottom of the pallet and the ribbed 1/8" x 3" steel plate on the bottom of the pallet conformed to the shape of the loads of bagged sugar. The "Fibreboard Deck," deflected to a greater degree where the bottom bags of sugar on the pallet were not placed parallel to the deck supporting wires. When the loads were removed at the end of one month the pallet did not return to its original shape.

It was also noted that the Fibreboard deck ruptured and cracked due to the non-rigidity of the bagged goods load. These cracks appeared along the pallet deck just above, and in line with the .264" horizontal wires. The exposed ends of the vertical support wires also punched through the Fibreboard top of the pallet. Both of these conditions are indicated in Photo Negative #50-2, Page 25. This failure was due to concentration of weight above the supporting members as is encountered with non-uniformly distributed loads.

The upper two pallets shown in Photo Negative #28-1, Page 21 did not show any failure. In these cases there was no damage since there was not as much weight on the pallets and also since the load was uniformly distributed over the entire top of the pallet.

It was also noticed that when bagged goods were used upon the lower pallets, and additional pallets tiered to form a stack, the stack would incline in an unsafe manner due to insufficient bearing surface on pallets adjacent to bagged goods. This condition is indicated in Photo Negative #28-1, Page 21.



RUPTURE OF FIBREBOARD LINER RESULTING FROM HUMIDITY OF PACKED GOODS LOAD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
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PHOTO NEG. NO. 50-2 PAGE 25

Information obtained on later load capacity tests when each of the two types of steel wire pallets were subjected to total loads of 15,176 lbs showed that the Steel Wire Pallet (Rolled Expanded Metal Deck) was satisfactory for such loading over a minimum time of one month. It was also found that the Steel Wire Pallet (Fibreboard Deck) was <u>not satisfactory</u> under such loading. After one weeks time the Fibreboard Deck cracked under th load and such cracking occurred over the supporting wires of the deck. Cracks and actual breaks also occurred in line with the wood box edges of the boxed load above the Pallet. In at least one case, breakage of the deck occurred entirely around an area of approximately 18 square inches and this piece was, in effect, "punched out" and dropped down to the warehouse floor. In moving the Presdwood deck pallet with another pallet load on top, upon completion of this test, an accident occurred which caused a spilling of both loads upon the warehouse floor. The fork truck operator claimed that the weakened Presdwood deck pallet started to give way and that he was unable to lower the load in time to save it. Investigation of the pallet revealed it to be in an unsatisfactory condition with no support being afforded by the broken deck.

<u>CONCLUSIONS</u>

The Steel Wire Pallet (Rolled Expanded Metal Deck) is satisfactory for conditions indicated by this load capacity test.

The Steel Wire Pallet (Fibreboard Deck) <u>does not</u> satisfactorily meet the requirements of the Load Capacity Test and use of such pallet under such loading conditions would be dangerous to warehouse personnel.

Conclusions for both types of Pallets as regards "Tiering Ability" and "Suitability for Bagged Goods" observed during this test are reported upon under Tests 3 and 4.

TEST #3 - TIERING ABILITY

STANDARD TEST PROCEDURE

Under Test #2 loads are to be applied to pallets for strength tests but the tiering ability of the pallets is to be noted under this Test #3 heading. A measurement is also to be made of the percentage of pallet bearing area in contact with a load underneath compared to the total top area of a pallet. Recommendations are to be given concerning tiering heights and observations are to be made concerning tiering conditions encountered with various commodities, particularly bagged goods, with each pallet tested.

The ability of a pallet to be efficiently and safely tiered is important in warehousing and storing and it is believed the above test will give information in this direction. The resistance of a pallet to sliding as encountered in load shifts in humping operations of railway freight cars will normally be a function of the percentage of pallet bearing area which will be indicated by this test.

TEST CONDITIONS

The test conditions applying to this test are identical with the test conditions listed under Test #2 since observations for this test were made during the conductance of Test #2.

TEST RESULTS

With both types of Steel Wire Pallets, satisfactory tiers were formed and maintained as long as the bottoms and decks of the pallets were in contact with level, flat, uniform loads such as are encountered with standard sized boxed goods.

When an attempt was made to tier both types of Steel Wire

Pallets on bagged goods, the results were not satisfactory due to insufficient bottom bearing area. Photo Negative #28-1, Page 21 illustrates a tier formed after much shifting of the top layer of bags in order to start with a level surface. Photo was taken after one months storage and indicates an unsafe condition for warehouse storage. The computed percentage of the bottom area to the total area enclosed by the top dimensions of the pallet is 21%. This is the same for both types of pallets. The percentage of bottom area to top area of a Standard Navy Wood Pallet is 59%. Photo Negative #28-2, Page 29 illustrates the good tiering conditions with bagged goods which results from use of Standard Navy Wood Pallets having the higher percentage of pallet bottom bearing surface compared to top surface.

CONCLUSIONS

Both types of Steel Wire Pallets are satisfactory for tiering conditions only where the loads carried below the pallets are level, flat, and uniform as is the case with standard boxed goods.

Both types of Steel Wire Pallets are not satisfactory for tiering when used with bagged goods. This is due to insufficient bearing area of the pallet understructure. Use of such pallets for bagged goods tiering will result in inefficient and unsafe warehousing practice.

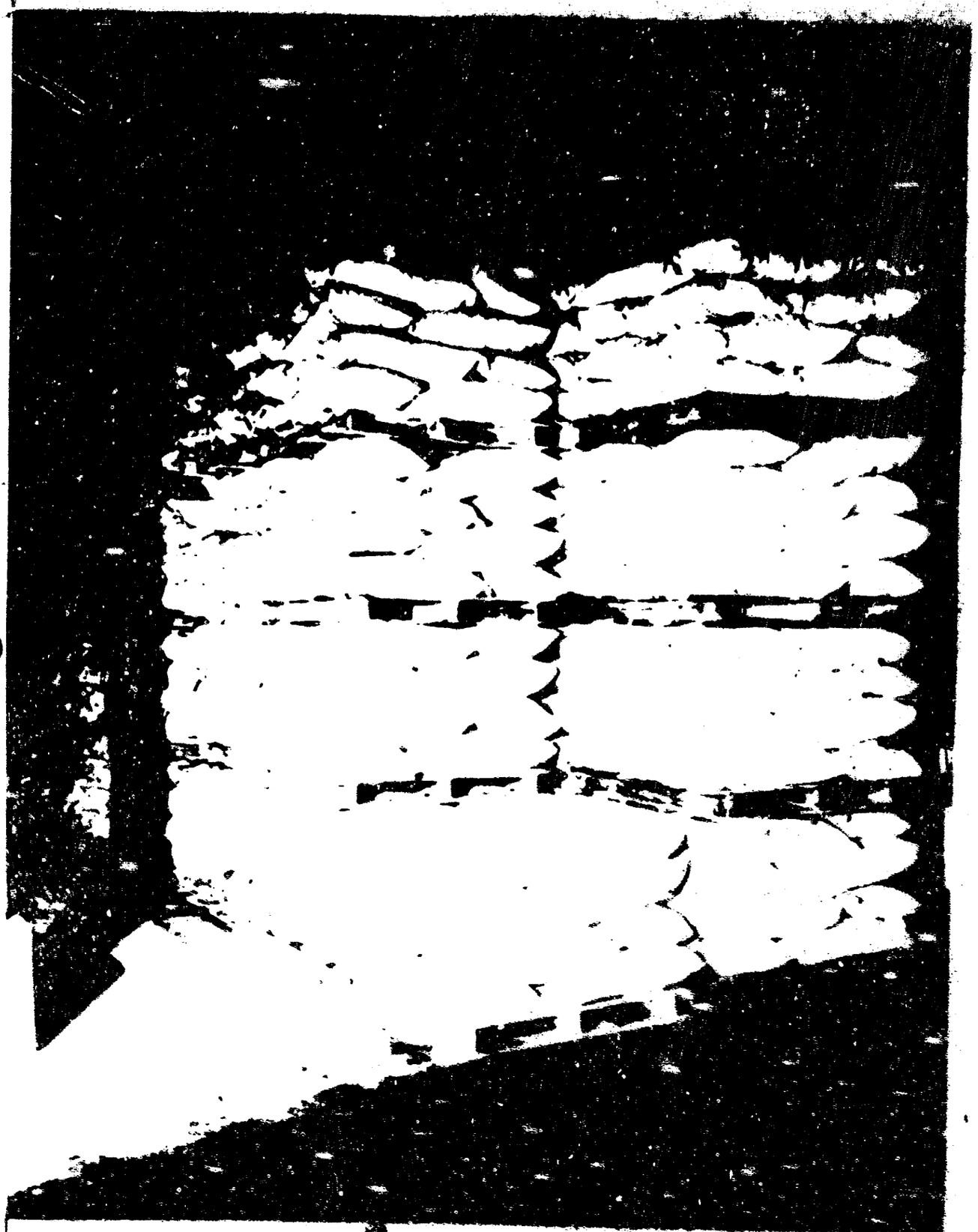


ILLUSTRATION OF GOOD PALLETIZATION OF BAGGED GOODS WITH STANDARD NAVY WOOD PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT
BAYONNE N J
PROJECT SERIAL NO NT-033-010
PHOTO NEG NO 28-2

TEST #4 - SUITABILITY FOR BAGGED GOODS

STANDARD TEST PROCEDURE

Each pallet will be investigated for suitability for use in palletising bagged goods. Although Test #3 indicates that observations will be made to show tiering effects on bagged goods it is desired that in this test suitable recommendations be made concerning the general suitability of the pallet for bagged goods palletising.

Practical experience has indicated that large open spaces, either in the top or bottom of a pallet will permit bagged goods to project through with possible injury to the bags by the forks of a lift truck. Sharp corners and projections arising from general usage and a loosening of component parts may cause injury to bags if the pallet is not properly designed and it is believed the above test will indicate general suitability.

TEST CONDITIONS

Both the Steel Wire Pallet (Rolled Expanded Metal Deck) and the Steel Wire Pallet (Fibreboard Deck) were loaded with 100 lb bags of sugar and were tiered by warehouse personnel under usual warehouse conditions as indicated by Photo Negative #28-1, Page 21. The bottom pallet had the Rolled Expanded Metal Deck and carried a total load of 9013 lbs. The next pallet was the Fibreboard deck type and carried a total load of 7860 lbs.

The proper palletisation of bagged goods ordinarily requires that the bottom surface of the pallet have approximately 2/3 the bearing area of the top surface of the pallet in order that the bagged goods will not project through the bottom part of the pallet and in order that a firm base may be provided for loads which may be tiered above. The Navy Standard Wood Pallet is an example of an excellent

pallet for use in the tiering of bagged goods. An example of such tiering is illustrated by Photo Negative #28-2, Page 29.

The percentage of bottom area to top area of an average Standard Navy Wood Pallet is 59%. The percentage of bottom area to top area for both the Steel Wire Pallet (Fibreboard Deck) and the Steel Wire Pallet, (Rolled Expanded Metal Deck) is 21%. When the percentage is as low as that indicated for the pallets under consideration, it is usually found that the bagged goods, being of a rather fluid nature, force themselves up into pallet openings and otherwise do not provide a stable and uniform load distribution. Such was found to be the case for the pallets being investigated. Much difficulty was encountered in forming a stable tier and when the tier was finally formed it was condemned as unsafe by the warehouse supervisor. Such tier is indicated by Photo #28-1, Page 21. A close up view of the tier is shown by Photo #28-7, Page 23. As may be seen by the enlarged view the bagged sugar projects down due to the flexibility of the Fibreboard Deck of the pallet and the bagged sugar from the load underneath projects through the open bottom spaces of the pallet. This results in a very bad condition when it is necessary to insert a fork truck into the pallet in order to move a load as the bags are then subject to tearing and considerable time is required to properly place the forks if it is at all possible to insert them. Photo #28-7, Page 23, also indicates the limited amount of bearing surface furnished by the wire construction of the underside of the pallet.

RESULTS

When the loads were removed from the pallets after one months time it was found that in the case of the Fibreboard Deck, Wire Pallet that where such pallet had been loaded with bagged goods and

submitted to a total load of 7250 pounds, the Fibreboard Deck had cracked and had punched through as indicated by Photo #50-2, Page 25. Such cracks in the pallet deck were due to concentrated loading directly over the vertical pillar wires separating the top from the bottom of the pallet. These vertical wires cause a break through of the deck, due to the manner of welding the side of these wires to the sides of the horizontal deck support wires. This arrangement exposes the ends of the vertical wires to act as a pierce point through the deck.

CONCLUSIONS

The Fibreboard Deck, and the Welded Expanded Metal Deck, Wire Type Pallets are not suitable for use with banded goods when tiering is necessary, due primarily to lack of sufficient bearing surface in the design of the pallet bottoms. Such lack results in unsafe tiering stacks, and fork truck operations are hampered due to projections of the banded goods through the bottom openings of the pallets. The projections also subject the banding and contents to damage and loss.

The Fibreboard Deck Pallet was also found to be unsuitable for banded goods due to a permanent deformation of the Fibreboard Pallet deck were banded to the deck caused by the pallet's structural wires projecting thru the deck.

TEST #5 - OVERLOAD TEST

STANDARD TEST PROCEDURE

Each pallet shall be individually tested for overload conditions with a uniformly distributed load of 40,000 lbs. to be held for one hour.

It is not believed pallets will ordinarily be subjected to total loads above 20,000 lbs. but in rare instances it may be necessary to store items of greater weight on pallets and this test is intended to give an indication of overload capabilities of the pallets.

TEST CONDITIONS

An endeavor was made to load each wire type pallet with a total load of 44,800 lbs. in 11,200 lb. increments. These increments were obtained with the use of cast iron blocks equipped with lifting hooks and normally used in dry dock operations. The size of the blocks is 27" x 27" by 5' length, permitting two such blocks to distribute the load evenly over the face of the pallet. Although the total weight of 44,800 lbs was greater than the suggested weight of 40,000 lbs, it was necessary to utilize the greater load for purposes of lifting convenience. An empty pallet of each type was placed on a concrete foundation asphalt road that provided a sufficiently flat rigid support. The 11,200 lb. blocks were carefully loaded on the pallet one at a time with the use of conventional rigging equipment and a mobile crane.

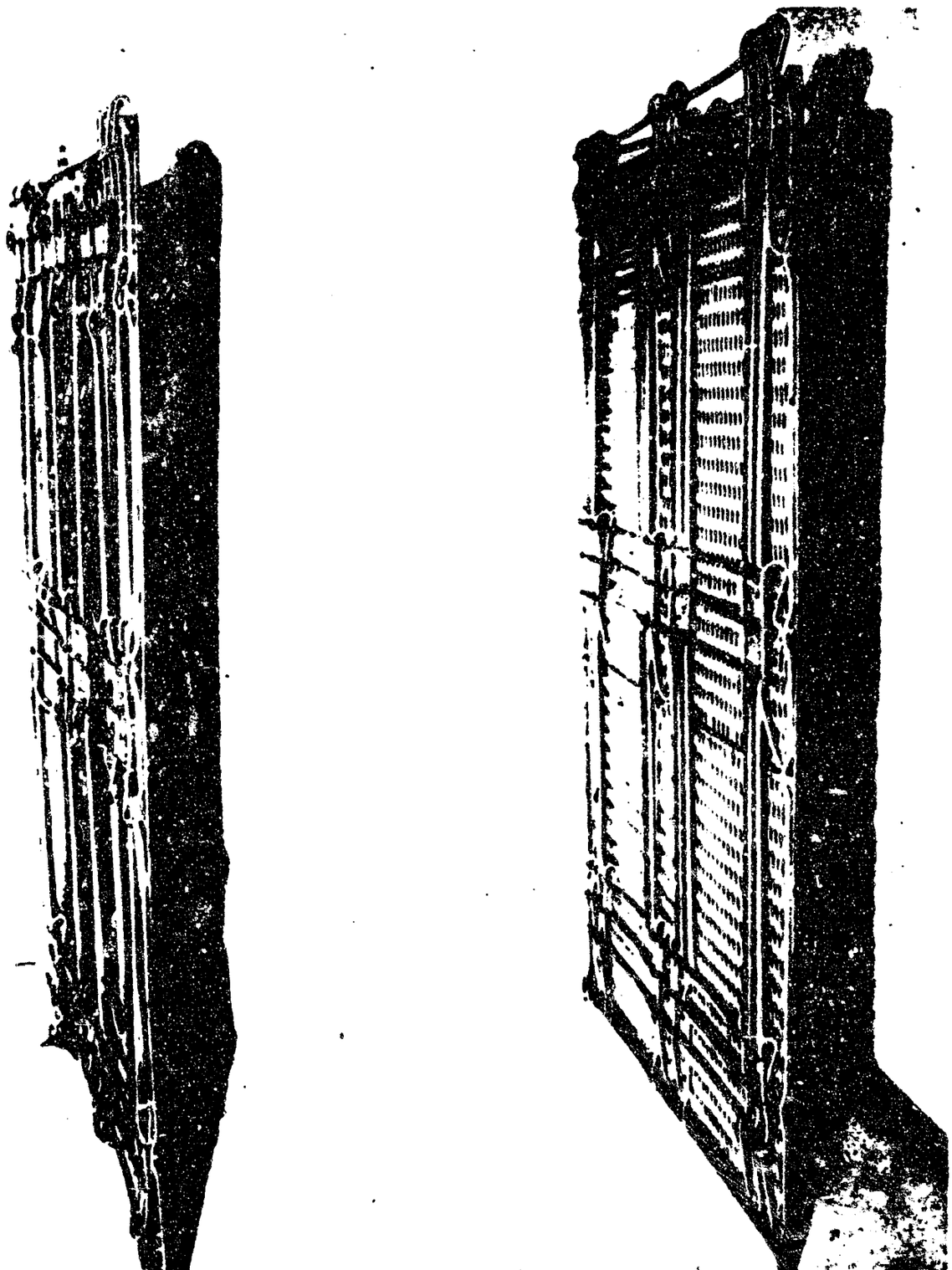
During the loading cycle, observations were made to detect possible areas of failure at each loading step. When the 44,800 lbs. were placed on the pallet, this total load was to be allowed to stay for one hour at which time the pallets were to be unloaded and

inspected for structural failures. The Standard Navy Wood Pallet was also subjected to the conditions of this test for comparative purposes.

RESULTS

A total load of 44,800 lbs. was placed on the Steel Wire Pallet (Rolled Expanded Metal Deck) without apparent signs of failure during the loading cycle. This load remained on the pallet for approximately one minute at which time the pallet suddenly collapsed and flattened to the ground. Inspection revealed that failure occurred by the bending of .310" dia. vertical support wires forming one side of the U shaped vertical posts. The bending of these wires followed one general pattern for all the "U" posts and was located at the lower section of the 4" high wire columns at the upper point of tangency of the bend of the "U" section. It was apparent from inspection that the o one side of the "U" section bent and failed as a column whereupon the load and the pallet deck shifted and caused the other leg of the "U" columns to straighten out from sidewise force instead of bending from a compressive action. The welds were all found to be intact. Examination of the asphalt ground surface showed the imprint of all the vertical posts to be similar and that the weight was reasonably transmitted proportionally down through each vertical stringer.

The Steel Wire Pallet (Fibreboard Deck) was loaded to 22,400 lbs. without indications of failure. While the riggers were loosening the shackles following the placement of the third 11,200 lb load the pallet suddenly collapsed and flattened out on the ground. Examination showed that failure occurred in much the same manner as the Steel Wire Pallet (Rolled Expanded Metal Deck). See Photo negative 67-7-, page 35 to observe this condition and note that the vertical .264



CONDITION OF STEEL WIRE PALLETS FOLLOWING TEST #5, OVERLOAD TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-74 PAGE 35

dia. wires forming the "U" posts on one side of the pallet bent in opposite directions indicating a non-shifting effect with that side of the top deck. Two of these "U" posts were found to be sheared where the posts are welded to the .264 longitudinal bearing bottom wires. The asphalt ground surface beneath the pallet indicated by indentations underneath the vertical posts that the weight was reasonably distributed down through all the vertical stringers.

It was noted that the direction of understructure collapse was identical for both types of steel wire pallets. Photo Negative # 67-74 , Page 35 indicates such failure occurring in a direction parallel to the 3" wide metal bottom plates.

The Standard Navy Wood Pallet loaded with the total load of 44,800 lbs satisfactorily maintained this load for a period of one hour. When the pallet was unloaded and inspected, there were no signs of failure. It was noticed, however, that there was a slight permanent compression of the bottom boards of the pallet indicated by a 1/16" exposure of the heads of the drive screw nails on that pallet side, whereas before conduction of this test, such nailheads were flush with the bottom boards of the pallet.

CONCLUSIONS

Both types of pallets are not satisfactory for and cannot maintain a load of 44,800 lbs. The Steel Wire Pallet (Rolled Expanded Metal Deck) was found to have more compressive strength than has the Fibreboard Deck type. This condition is attributed to the fact that the vertical "U" stringer posts of the Rolled Expanded Metal Deck Pallet are constructed from .310" dia. wires. This presents a considerable difference compared to the .264" dia. wires utilized for the "U" shaped post supports of the Fibreboard Deck Pallet.

It is to be noted that both pallets were able to maintain a 15,000 lb. load for a one month stowage period in Test #2 of the Standard Test Procedure.

The Standard Navy Wood Pallet has indicated that it will adequately maintain a load of 44,800 lbs for a period of one hour.

TEST #6 - SHOCK LOADING

STANDARD TEST PROCEDURE

Each pallet shall be loaded with a uniform weight of approximately 3,500 pounds. One side of the pallet shall be lifted to a height of 24" and then suddenly dropped. Pallet will then be examined for failure or deformation. Each pallet shall be subjected to three of such drops and a report made on the condition of the pallet.

In actual practice it is found that pallets are often subjected to severe shock by inexperienced or careless operators of materials handling equipment. This test has been devised to indicate each pallets reaction to such shock loading under average maximum load.

TEST CONDITIONS

Both the Steel Wire Pallet (Rolled Expanded Metal Deck) and the Steel Wire Pallet (Fibreboard Deck) were loaded in a normal warehouse manner by warehouse personnel with wood boxes containing steel edge protectors and weighing 208 pounds per box. The weight of the boxes did not permit the warehouse laborers to pick up and place the load on the pallet. It was necessary to push each box on edge to its position and then drop the box from its corners onto the pallet deck. The two pallets were loaded to 3330 lbs each and steel strapped. The loaded pallets were then tilted up on one end by fork truck to approximately 24" high (See Photo Negative #40-6, Page 39 and dropped suddenly by backing the fork truck away from the pallet. This procedure was repeated three times with each pallet.

RESULTS

(1) The Steel Wire Pallet (Broadwood Deck) cracked and broke through when the first box was dropped to the pallet deck by the warehouse

ILLUSTRATION OF TEST CONDITIONS FOR TEST#6, TRUCK LOADING.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 40-6 PAGE 39

laborers during pallet loading operations. The approximate distance dropped by the corner of the tilted box was 16". Resulting damage is shown by Photo #28-6, Page 41.

(2) The Steel Wire Pallet (Rolled Expanded Metal Deck) absorbed very well and with no damage, the shock caused by the dropping of boxes on its deck.

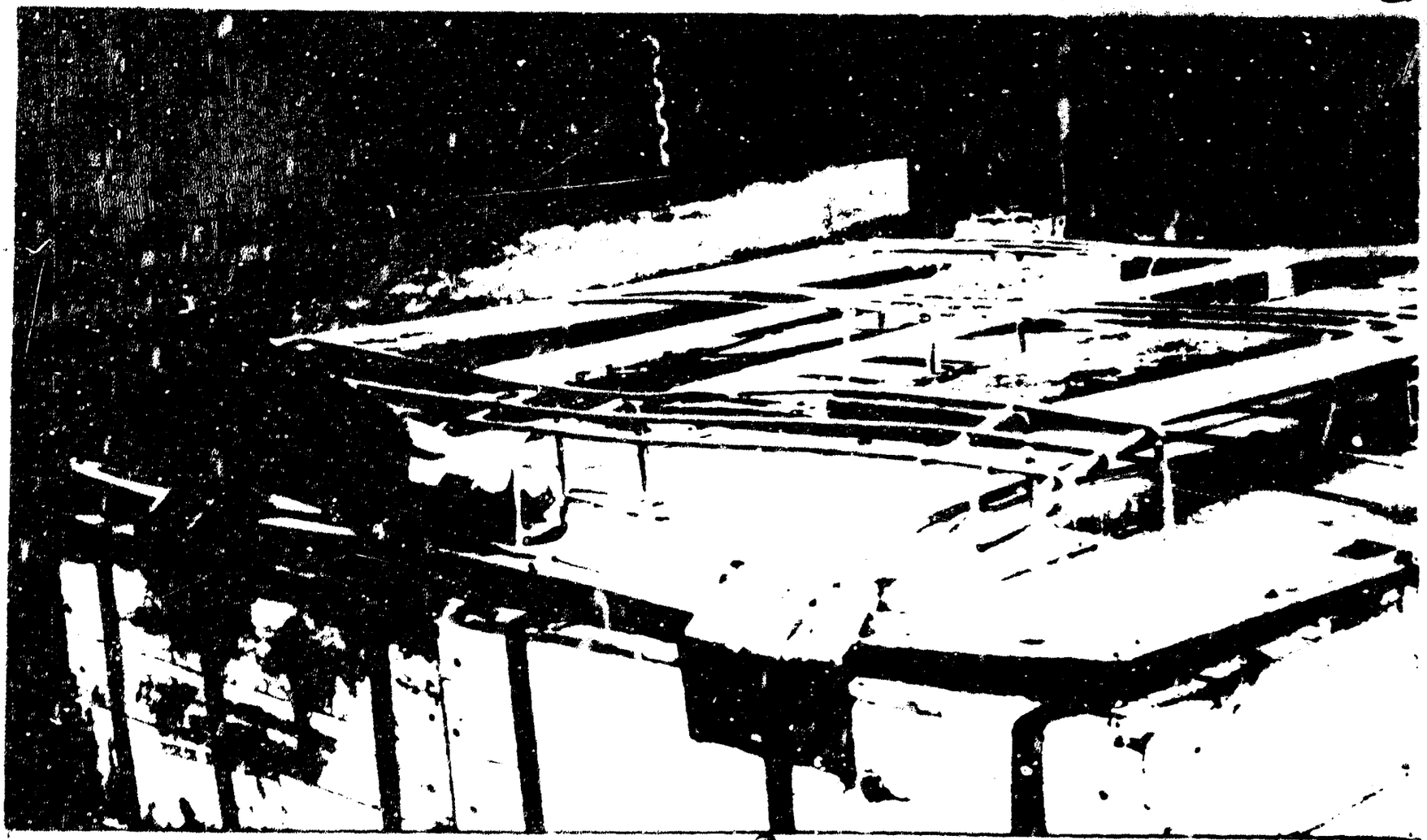
(3) When the tilted load was dropped to the ground the Steel Wire Pallet, (Fibreboard Deck) was found to be damaged due to a breaking through the deck of the support wires immediately below the pallet deck and also a punching through the deck of the vertical wires separating the top and bottom of the pallet. This damage is indicated by Photo #40-3, Page 42.

(4) The Steel Wire Pallet (Rolled Expanded Metal Deck) when submitted to the drop test showed no damage or deformation of the pallet structure.

(5) Damage resulting from shock conditions was accidentally demonstrated during preparations for Test #7, "Towing Test". Such illustration of damage is included here as a matter of information and is indicated by Photo #51-4, Page 43. A Steel Wire Pallet (Fibreboard Deck) was loaded with a wire strapped 3500 lb. load and this pallet accidentally toppled to the ground from a moving five foot high trailer flat truck during transportation to a remote test area. The load landed upside down with the pallet uppermost and resulted in considerable damage to the pallet. There was a complete breakage of the Fibreboard Deck and considerable bending of the wire understructure to conform to the shape of the fallen load. It is to be noted that the Fibreboard Deck contributes no strength to the Pallet Structure.

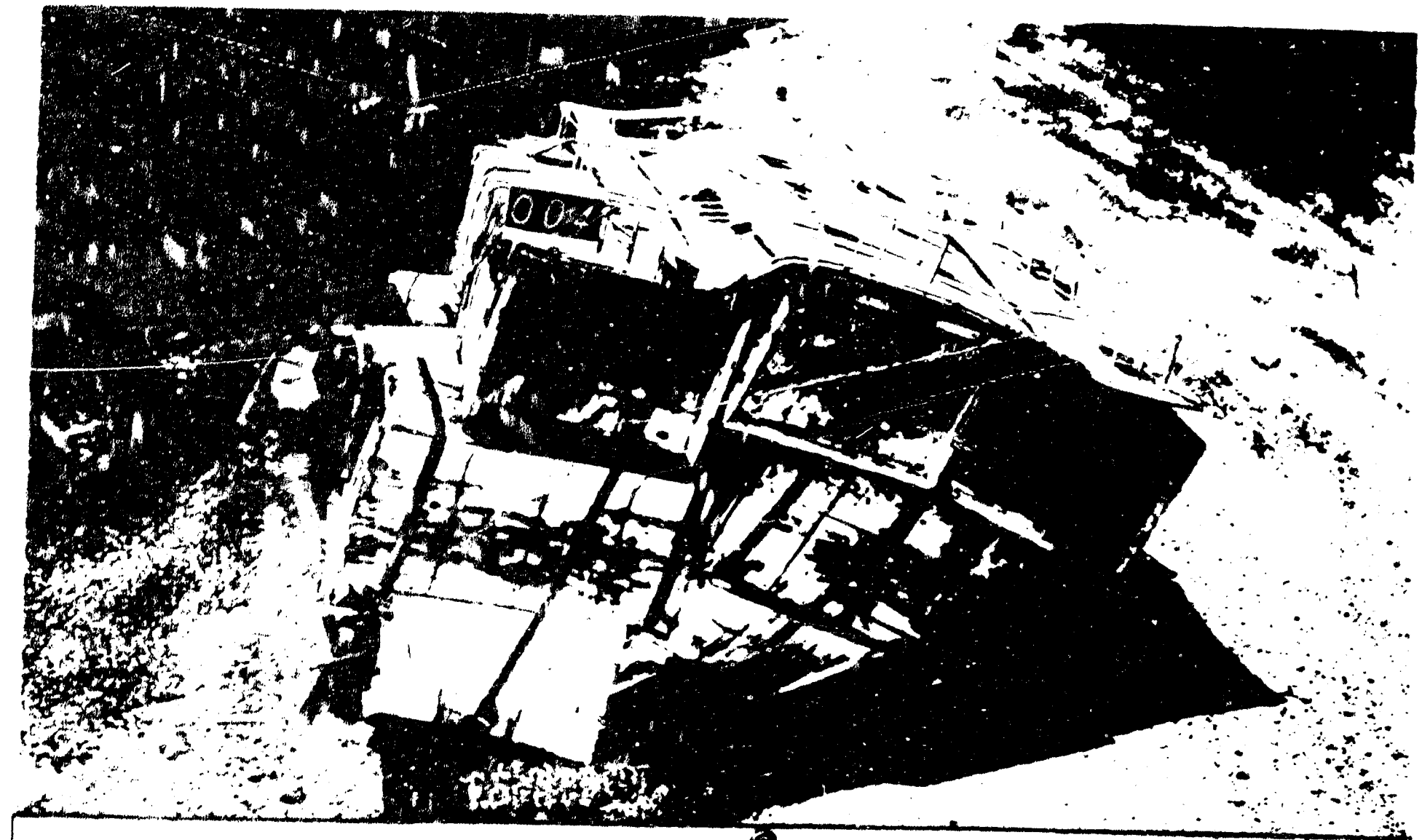
EFFECTS OF SHOCK LOADING ON THE FIBREBOARD DECK PALLET. DAMAGES RESULTED WHEN BOXED LOAD WAS DROPPED ON THE DECK.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 26-4 PAGE 44



DAMAGES RESULTING TO THE FIBREBOARD DECK PALLET WHEN PALLET WAS TILTED 24" AND DROPPED FOR SHOCK LOADING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 40-3 PAGE 42



DAMAGES RESULTING TO THE FIBERBOARD DECK PALLET AFTER ACCIDENTALLY TOPPLING TO THE GROUND FROM A MOVING FLAT TRUCK.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 51-4 PAGE 43

CONCLUSIONS

(1) The Steel Wire Pallet (Fibreboard Deck) is not suitable for use when submitted to rough treatment or shock loading conditions due to the resulting damage to the Fibreboard Deck.

(2) The Steel Wire Pallet (Rolled Expanded Metal Deck) is satisfactory for use in which normal warehousing treatment or shock loading is involved. This pallet was found to be very resilient to such loading and could very well absorb shock damage without injury to the pallet load or to the pallet.

TEST #(TOWING TEST - UNSUPPORTED

STANDARD TEST PROCEDURE

Each pallet shall be tested for its capability for being dragged on sand, wood, concrete, and earth for a minimum distance of 300 feet while uniformly loaded by a weight of approximately 3,500 pounds. Dragging shall be by means of a drag hook, as utilized for Standard Navy Wood Pallets, or by cables attached to each pallet. Reports shall be made in regard to the successful passing of such test by each pallet without excess distortion or failure of the pallet structure and a report shall also be made of the extent to which each pallet tends to "dig in" instead of sliding over each type of material indicated.

The above test has been devised to indicate suitability of pallets for emergency movements as might be required by the Navy Department in time of war, wherein lack of, or damage to, proper mechanical facilities would necessitate dragging instead of carrying the pallets.

TEST CONDITIONS

Pallets were loaded with 3,500 lbs of wood [illegible] steel edge protectors. The load was steel strapped to each pallet and the pallets were then submitted to dragging runs over varying ground conditions as listed. A steel wire cable was used to pull each pallet. This cable was rigged to a caterpillar tractor which furnished the towing power. For the tests over a gravel road and in sand and soft dirt the towing cable was merely wrapped around the four stringers of the pallet which separate the top from the bottom of the pallet, and the cable was then connected to the tractor. For the tests conducted over rough terrain,

the cable was wrapped around the middle stringers separating the bottom from the top of the pallet and then to the caterpillar tractor.

The type of test grounds over which the pallets were towed were of three types as follows:

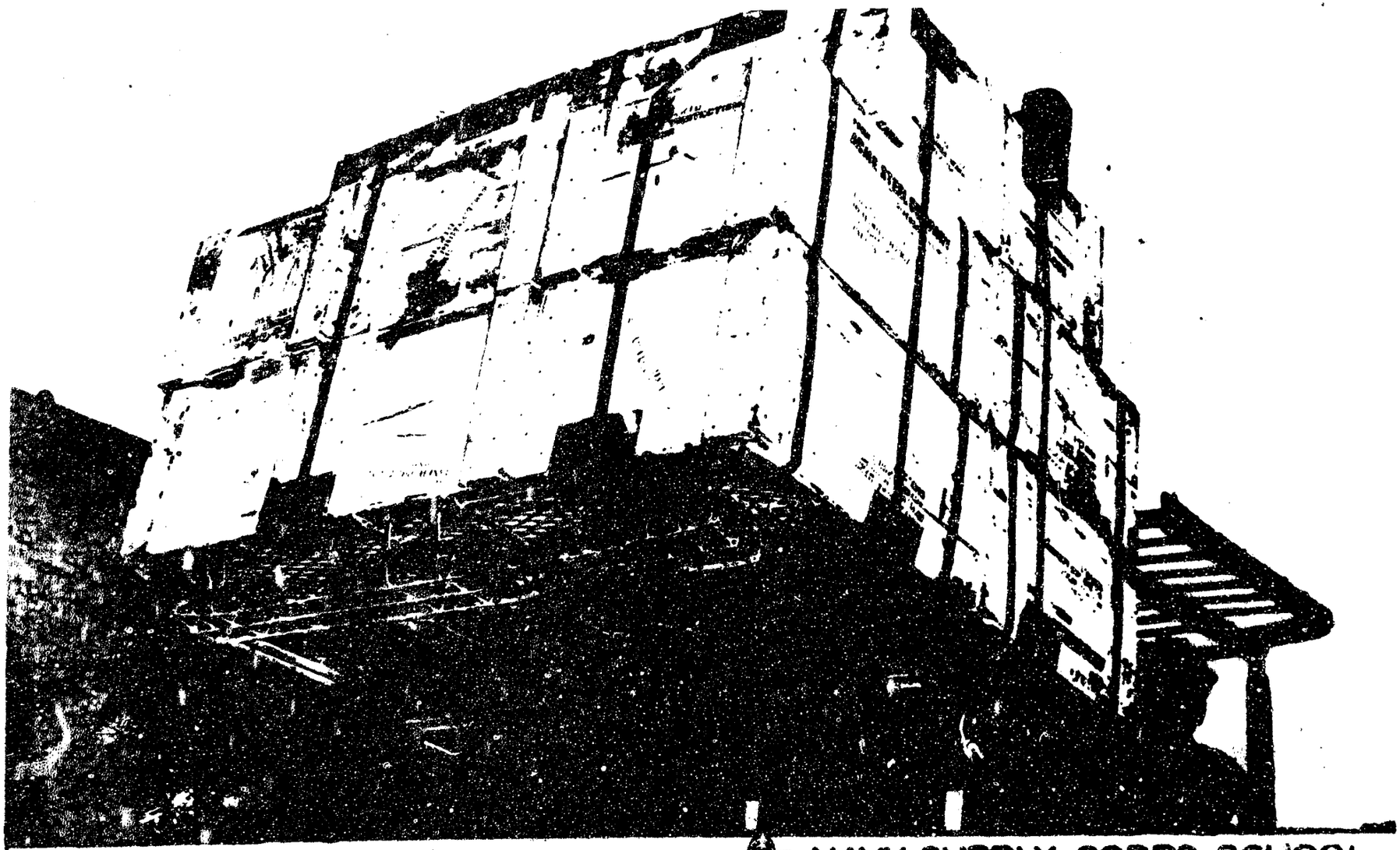
1) A 300 ft. run over a level, course gravel, road.

2) A 600 ft run over sand and soft dirt which included slight up and down grades and a sharp right angle turn at waters edge on a beach.

3) An 1100 ft run over rough course of varying slopes and inclinations composed of brush, logs, weeds, stones up to 12" in diameter, wooden debris, old concrete foundations and tall grass, several ditches about three feet deep and four feet wide, a sharp slope about 3 feet high, a three hundred foot length of cinder road, and [illegible]e right angle turns.

RESULTS

1) The bottom structure of both types of pallets showed considerable wear after being dragged over the 300 ft run of course gravel road. The .264" dia. pallet bottom wires, in contact with the road were found to have been ground down to .158" thickness where these wires crossed the vertical support wires. It is estimated that a continuation of this test for another 300 ft would have caused complete collapse of the bottom portions of the pallet. It was also found that the towing cable permanently bent the vertical .264" corner support wires where the cable was passed around the rear of the pallet. The welds bonding the vertical wires to the deck did not break apart. Photo #40-2, Page 47 indicates the position of the cable during dragging operation and damage resulting to corner wires.



PURCHASE OF TOWING CABLE AROUND STEEL WIRE. FAILED DURING TOWING OPERATIONS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003 010
PHOTO NEG. NO. 40-2

2) No serious damage resulted to the pallets when they were towed over sand, soft earth, and mud. Such towing conditions are indicated by Photo #42-3, Page 49. This test was conducted with the ground thoroughly saturated after a hard rain. In parts of the test course mud conditions existed and this mud caked itself between the top and bottom members of the pallet. The pallet was dragged with the 3" wide metal plates on the bottom of the pallet at right angles to the direction of travel as indicated in Photo #42-3, Page 49. Photo 42-0, Page 50 indicates condition of pallet upon completion of this part of the test. It may be noted that the 3" wide metal plates offer resistance when dragged in the indicated manner and are distorted but have not failed, (Later tests over rougher ground showed failure of such members when these plates were not placed in the direction of travel). Several large stones were also found firmly wedged in the pallets understructure.

3) The Steel Wire Pallet (Fibreboard Deck) was first towed over the rough 1100 ft course. During this run the 3" wide plates on the bottom of the pallet were dragged in the direction of pallet travel. The Presdwood Deck of the pallet did not rupture during this test run and the pallet did not overturn during the run. Photo #51-7, Page 51 indicates conditions just before completion of this test while pallet was being towed along the cinder road. Earth, weeds and debris may be noticed under the pallet. Such debris is better shown in Photo #51-8, Page 52 which was taken upon completion of this test run. Photo #51-9, Page 53 is another view of the same pallet shown in Photo 51-8, Page 52, but taken after removal of debris to indicate pallet damage. Severe distortion of the bottom structure is apparent, however, it is particularly important to note that the vertical support

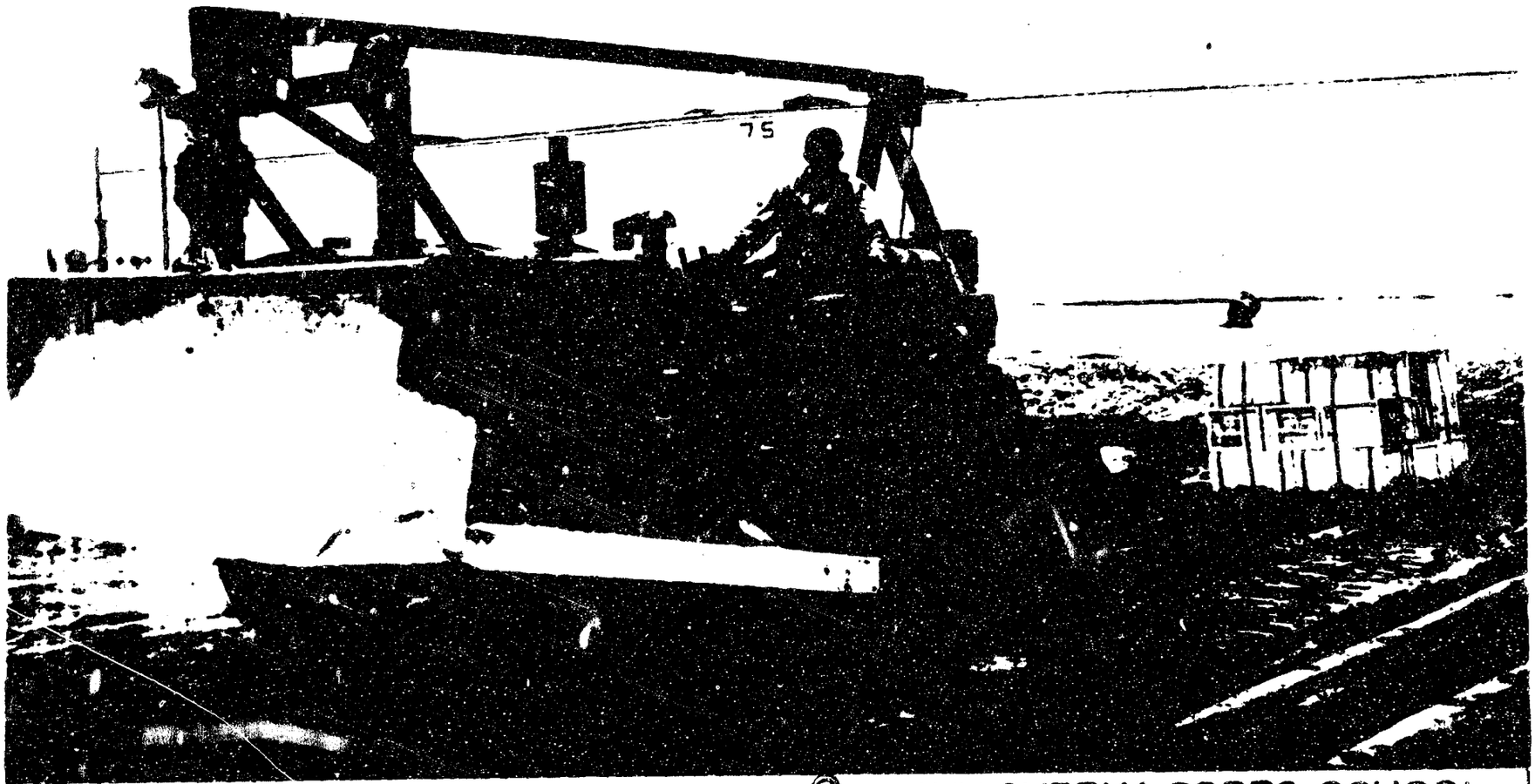
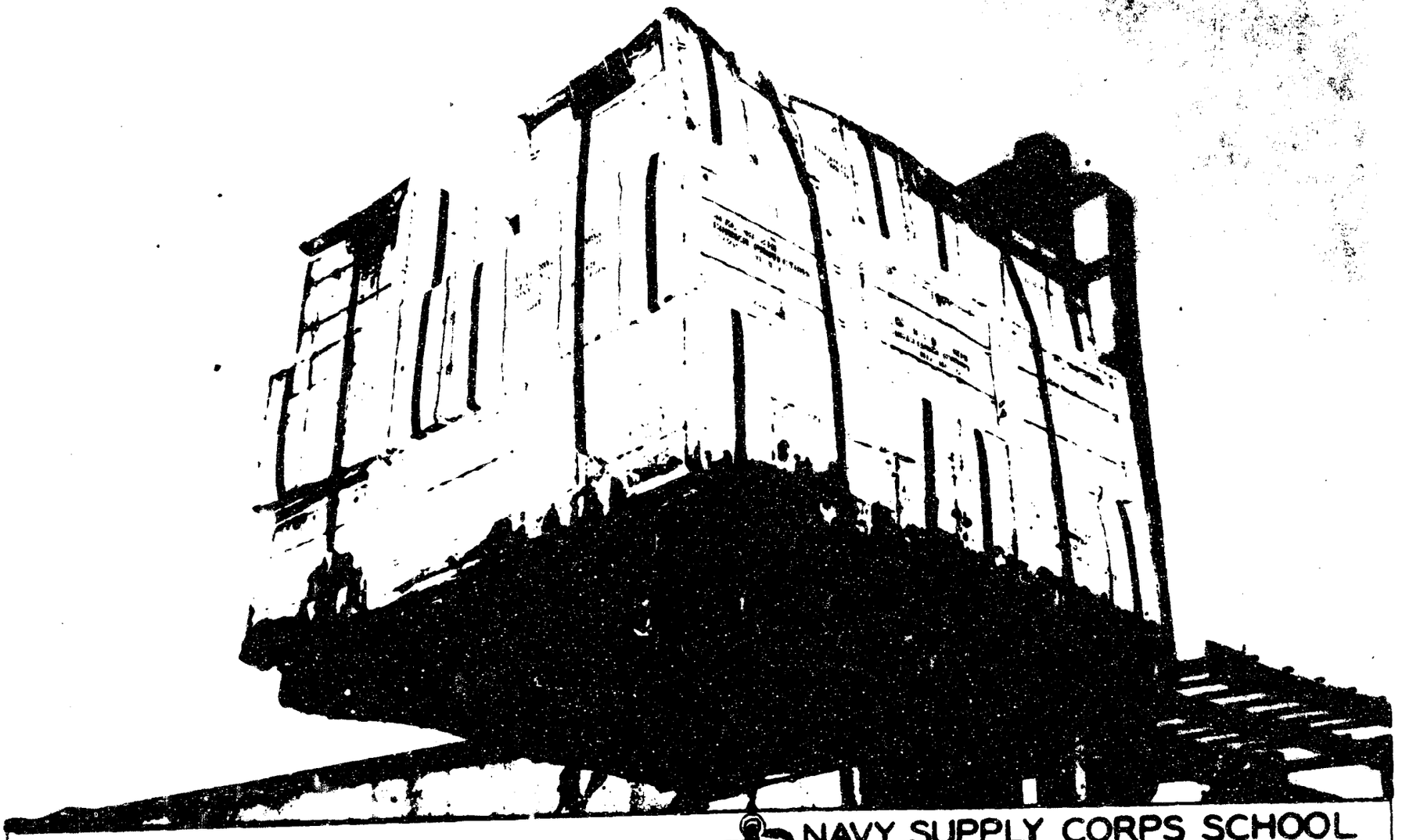


ILLUSTRATION OF TOWING CONDITIONS OVER SAND, SOFT EARTH AND MUD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-3 PAGE 49



MUD CAKED CONDITIONS IN UNDERSTRUCTURE OF STEEL WIRE PALLET AFTER BEING TOWED UNSUPPORTED OVER SAND, SOFT EARTH AND MUD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-0 PAGE 50

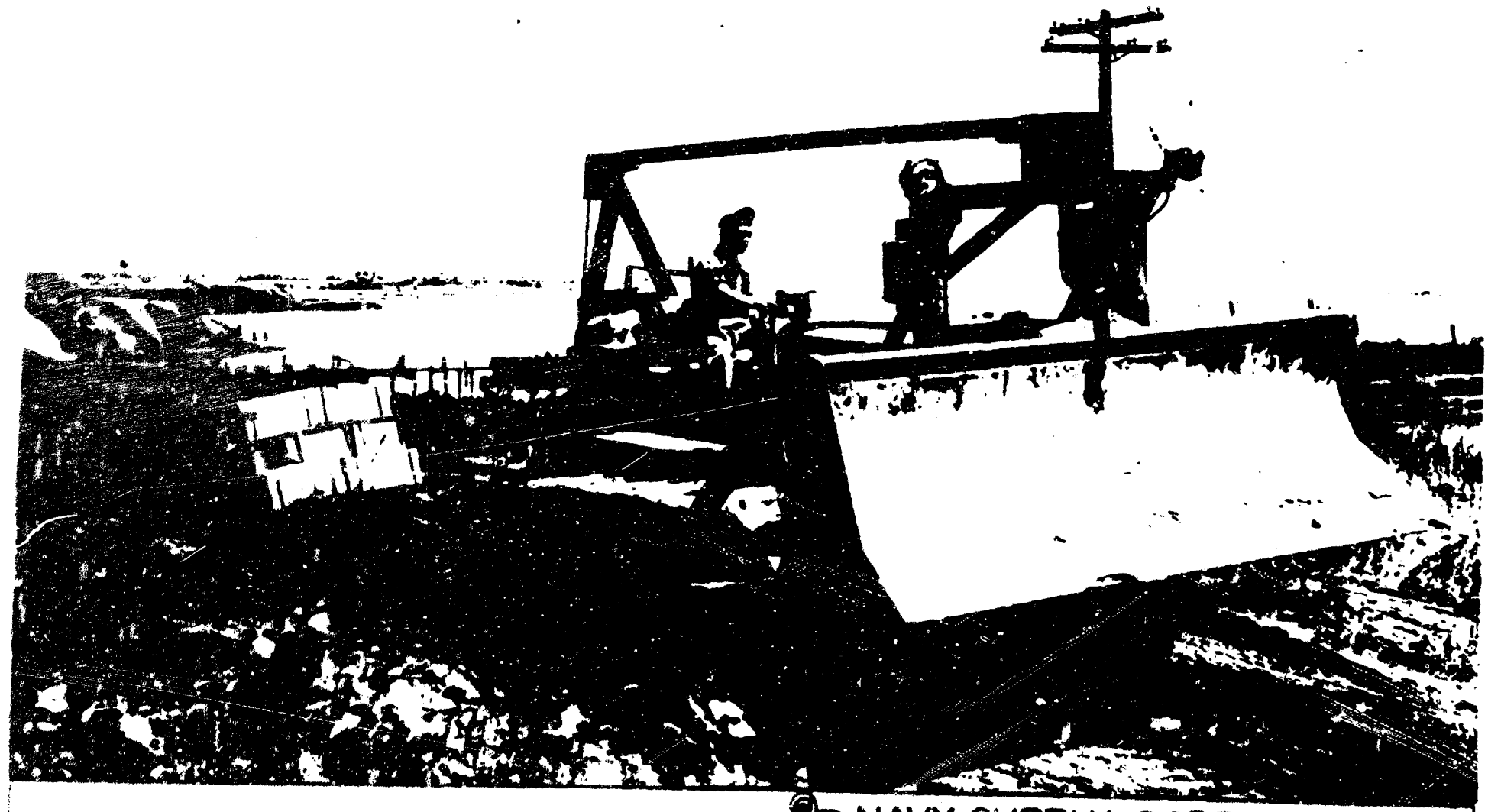


ILLUSTRATION OF CONDITIONS JUST BEFORE COMPLETION OF UNSUPPORTED TOWING TEST OVER ROUGH TERRAIN WITH FIBREBOARD DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 51-7
PAGE 51

ACCUMULATION OF DEBRIS FOLLOWING UNSUPPORTED TOWING OPERATIONS OVER ROUGH TERRAIN WITH THE FIBREBOARD DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO. 51-8

CONDITION OF FIBREBOARD SKK PALLET UNDER-STRUCTURE AFTER REMOVAL OF DEBRIS ACCUMULATED DURING UNSUPPORTED TOWING TEST AND SHOWN BY PHOTO NO. 51-8

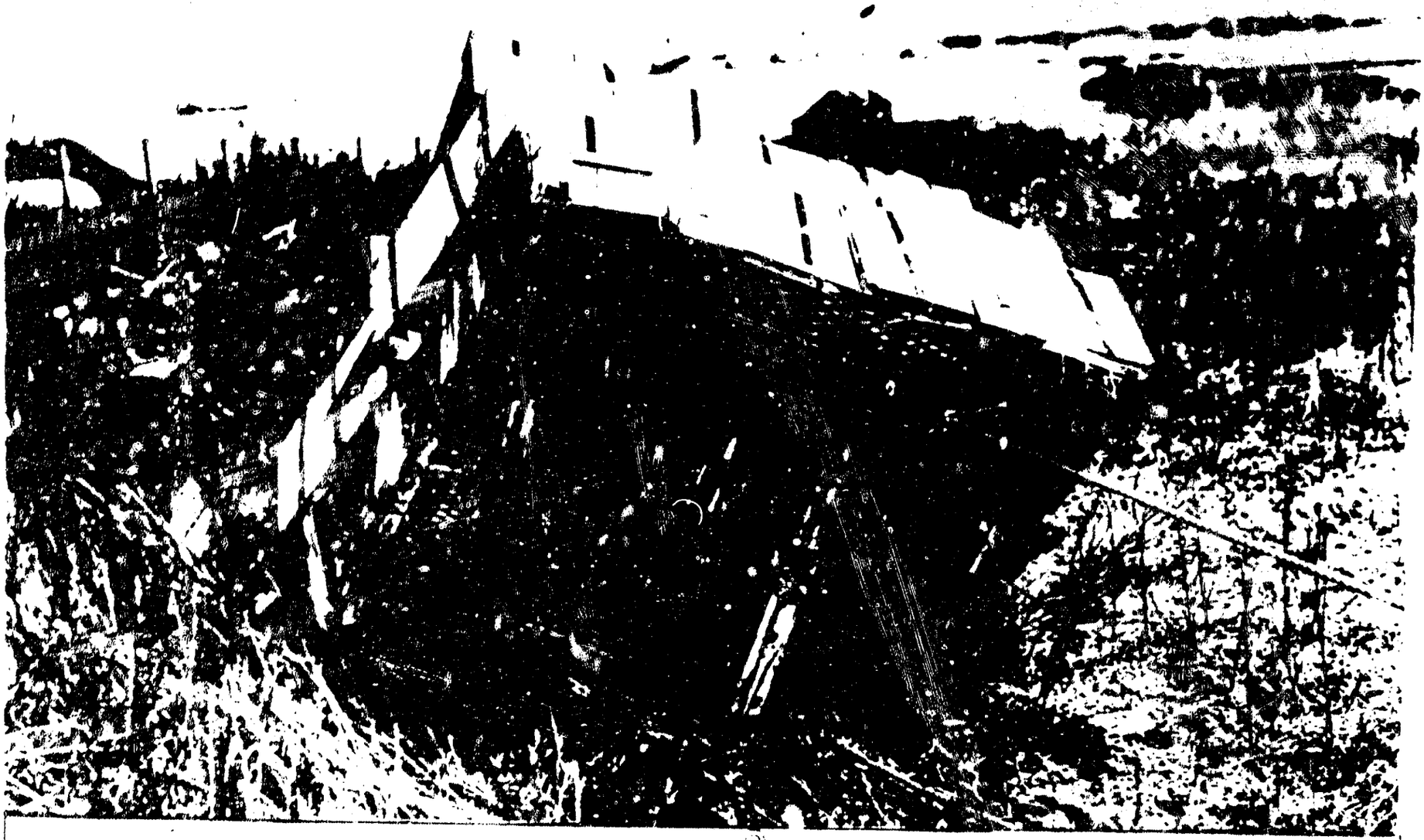
NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 51-9 PAGE 53

wires separating the bottom from the top of the pallet were only slightly bent. When this pallet was lowered to the ground there was no difficulty encountered in inserting the forks of a lift truck into the pallet, nor of lifting the pallet from the ground by means of the fork truck. Photo 51-9, Page 53 also shows a loosening of steel strpping which occurred during this test.

4) Since the under structure of both types of pallets are identical it was decided to conduct the towing test over rough terrain for the Steel Wire Pallet (Rolled Expanded Metal Deck) with the 3" wide metal plates across the direction of travel in order to provide a comperison with the previous test where these plates were placed and pulled in the direction of travel. This pallet towed satisfactorily for approximately 500 ft as indicated by Photo #51-010, Page 55, taken after 450 ft and moving up-hill. This photo indicates a digging in effect of the crosswise 3" wide bottom plates by condition of the ground over which it is traveling. At approximately the 500 ft point the pallet overturned when attempting to cross a 3 ft deep ditch which contained large rocks. Photo 51-11 Page 56 indicates the condition of the pallet at this point shortly after tension had been applied in an effort to right the pallet. Towing with the 3" plates crosswise to the direction of travel caused considerable distortion and failure of the bottom structure. It may be observed that under righting tension the welds for the center vertical support wires gave way at the juncture to the metal deck. After the welds at the center section gave way it was necessary to drag the pallet in such condition approximately an additional 500 ft with the end results as shown in Photos 51-12, Page 57 and 51-13, Page 58. No attempt was made to move the pallet after initial failure by taking particular care in handling as it was

EXPANDED METAL DECK PALLET BEING DRAGGED OVER ROUGH TERRAIN FOR TOWING TEST (UNSUPPORTED) WITH 3" WIDE BOTTOM PLATES 90° TO TRAVEL.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE, N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 59-10 PAGE 55



EXPANDED METAL DECK PALLET BEING Rrighted AFTER OVERTURNING WHEN ATTEMPTING TO CROSS A 3 FOOT DEEP DITCH OF THE TOWING UNSUPPORTED TEST COURSE.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 51-11 PAGE 56

END RESULTS OF EXPANDED METAL DECK PALLET AFTER BEING DRAGGED IN A DAMAGED CONDITION FOR 500 FEET IN THE TOWING UNSUPPORTED TEST OVER ROUGH TERRAIN.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 51-12 PAGE 27

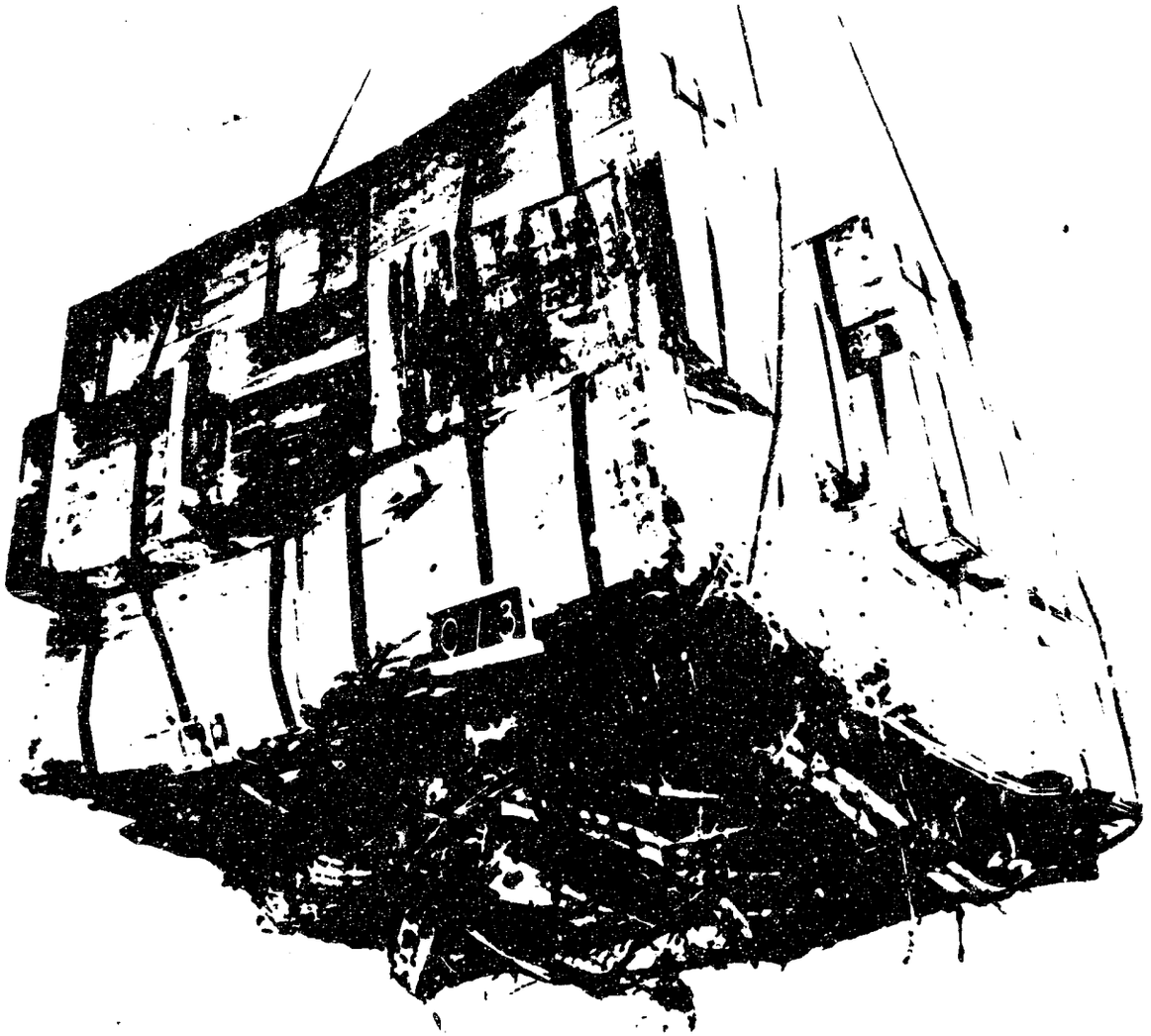


ILLUSTRATION OF STEEL WIRE PALLET DISTORTION AFTER EXTENDED PUNISHMENT IN TOWING OPERATIONS UNSUPPORTED.

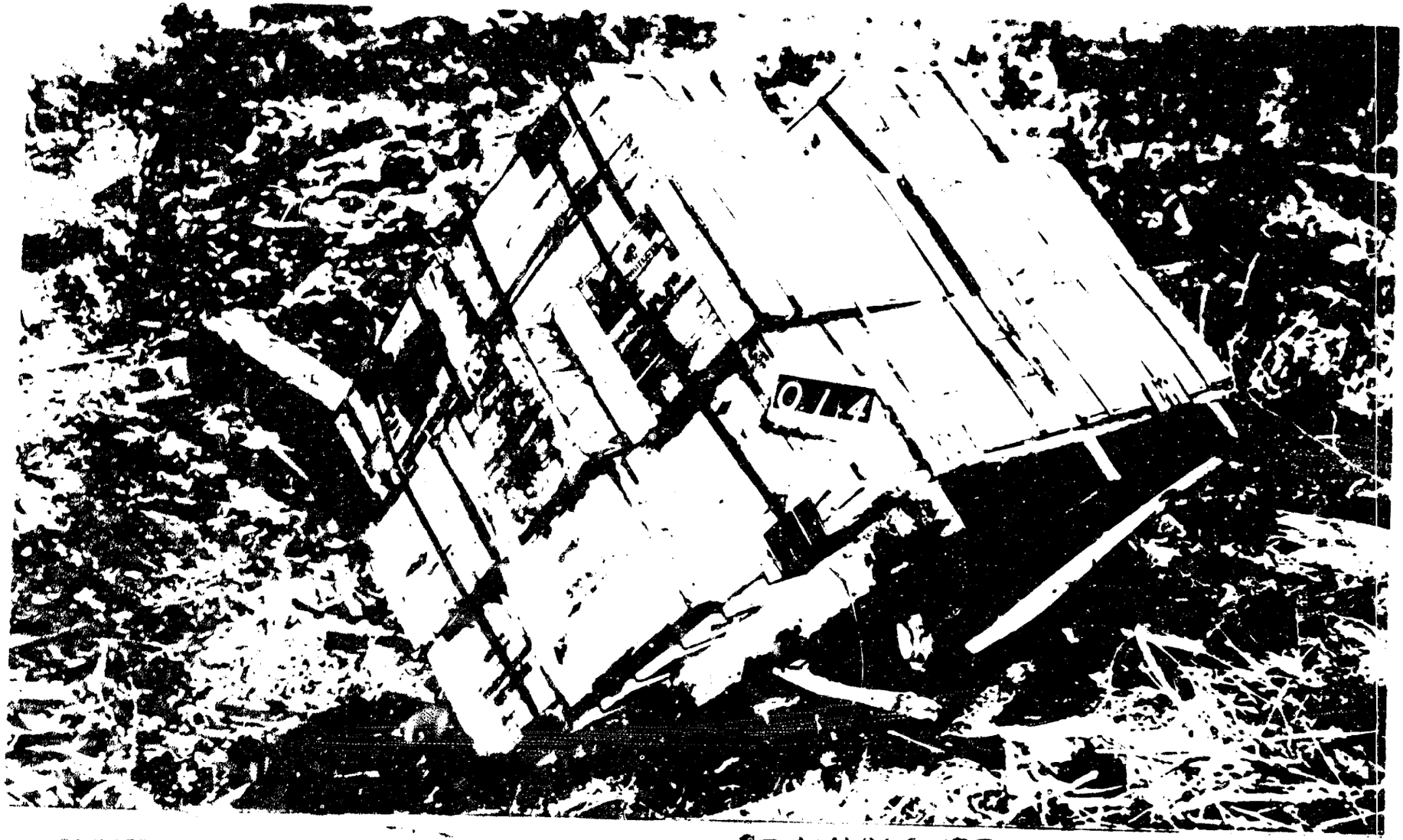
NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO. 51-13

believed such conditions would not be representative of actual combat handling.

5) In order to obtain comparative data, a Standard Navy Wood Pallet with an identical load was also towed unsupported over the same test course. The bottom boards of the pallet were positioned with their length along the direction of travel and the towing cable was passed in back of the middle stringer member. After being towed approximately 600 ft several of the bottom boards broke loose when the pallet was dragged up an incline as indicated by Photo #51-14, Page 60. It was noted that only three of the drive screw nails pulled out of the stringers. In all other cases the nails held and the bottom boards tore off over the heads of the nails. In order to drag the pallet over the remainder of the test course it was necessary to wrap the towing cable around the load as indicated in Photo #51-24, Page 61, which also indicates the roughness of the ground traversed. The bottom boards were completely separated from the stringers at the completion of this run and the pallet was riding upon its stringers as shown by Photo 51-22, Page 62.

CONCLUSIONS

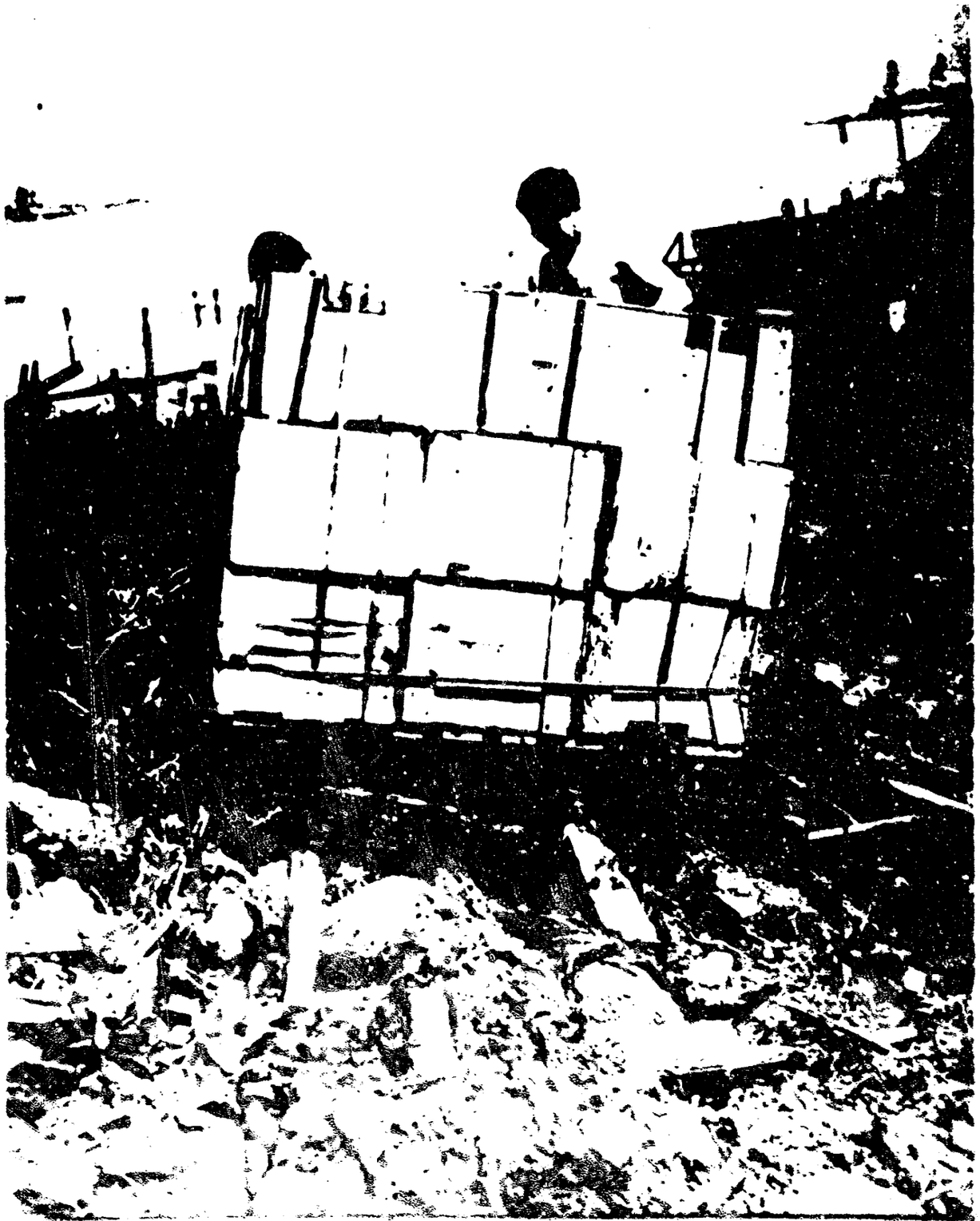
The Tests conducted on both the Steel Wire Pallet (Fibreboard Deck) and the Steel Wire Pallet (Rolled Expanded Metal Deck) indicate that both of such pallets may be dragged nominal distances over rough ground without serious damage to pallet or load providing the 3" wide metal plates on the bottom of the pallet are placed with their length in the direction of travel. Such members when dragged in this position serve as runners giving a stable bearing support. When the pallets are towed having these 3" wide plates with their length at right angles to the direction of travel, resistance of the pallet to movement is



CONDITION OF STANDARD NAVY WOOL PALLET AFTER BEING DRAGGED UNSUPPORTED OVER 600 FEET OF TEST SURFACE.

NAVY SUPPLY CORPS SCHOOL

PHOTO NO. 51-14



POSITION OF TOWING CABLE [illegible] SECURATION OF FOR- [illegible] WITH STANDARD NAVY WOOD PALLET IN UN- SUPPORTED LANDING TEST. [illegible] ROUGH TERRAIN.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 51-24 PAGE 61

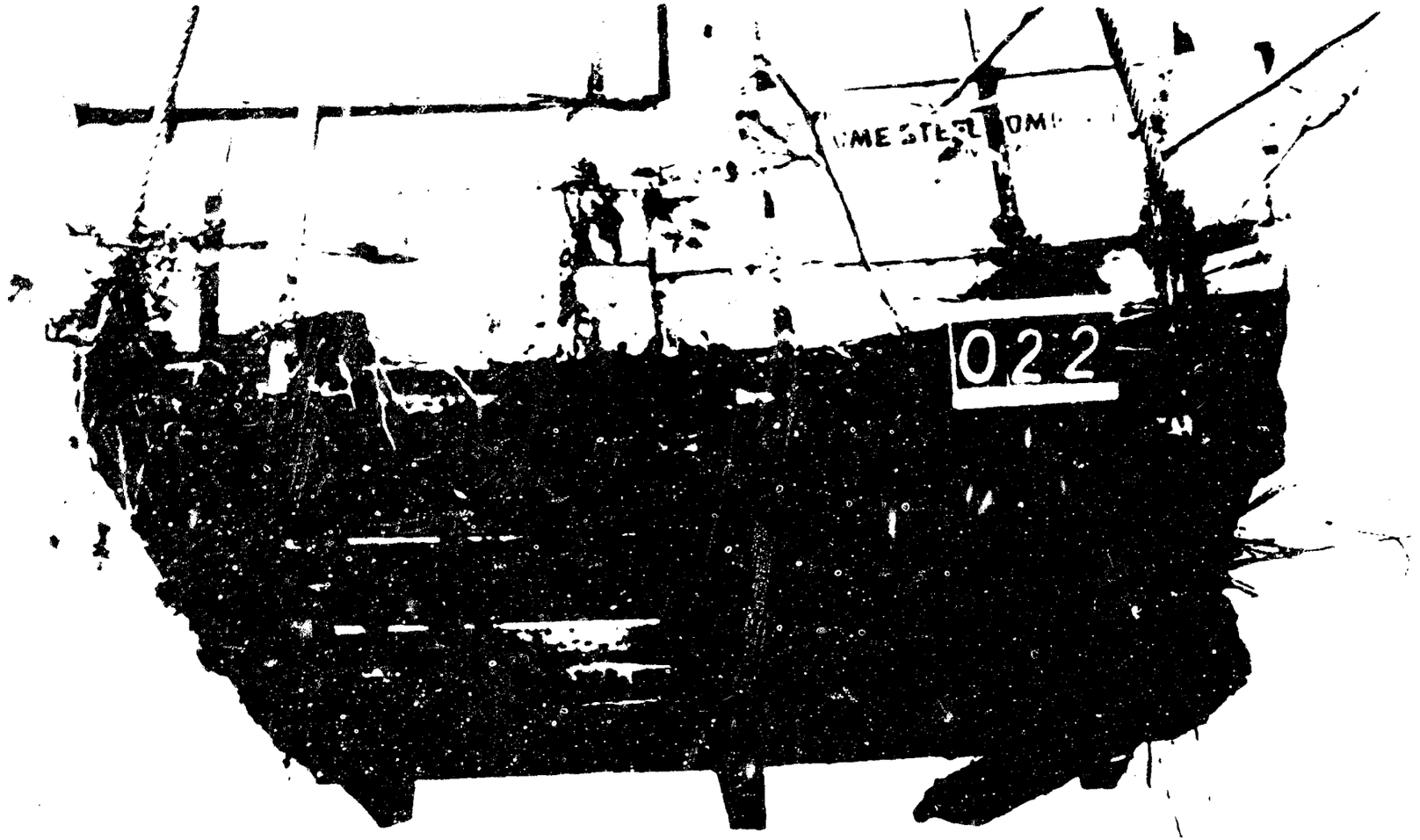


ILLUSTRATION OF THE STANDARD NAVY WOOD PALLET AT THE COMPLETION THE UNSUPPORTED TOWING TEST OVER ROUGH TERRAIN.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 51-22 PAGE 62

increased and damage to the pallet will result.

The underneath structure of both types of pallets, which is mainly composed of steel wires, does not offer much resistance to soft obstructing matter such as sand or mud. The pallets tend to sink in such material up to the deck level and the understructure merely plows through the undersurface without considerable resistance.

Both types of pallets tested for towing characteristics, unsupported, proved to be superior to the Navy Standard Wood Pallet under the same tests. However, both types of pallets could be strengthened for towing unsupported if such a characteristic is of primary importance. Considering the abusive treatment to which the pallets were subjected in this test, it is surprising that they stood up under such treatment as well as they did. In emergencies these pallets can be satisfactorily dragged unsupported for distances of at least a thousand feet over rough ground providing the bottom plates are in line with the direction of travel and not crosswise to the direction of travel.

TEST #8 - TOBOGGAN TOWING SUITABILITY TEST

STANDARD TEST PROCEDURE

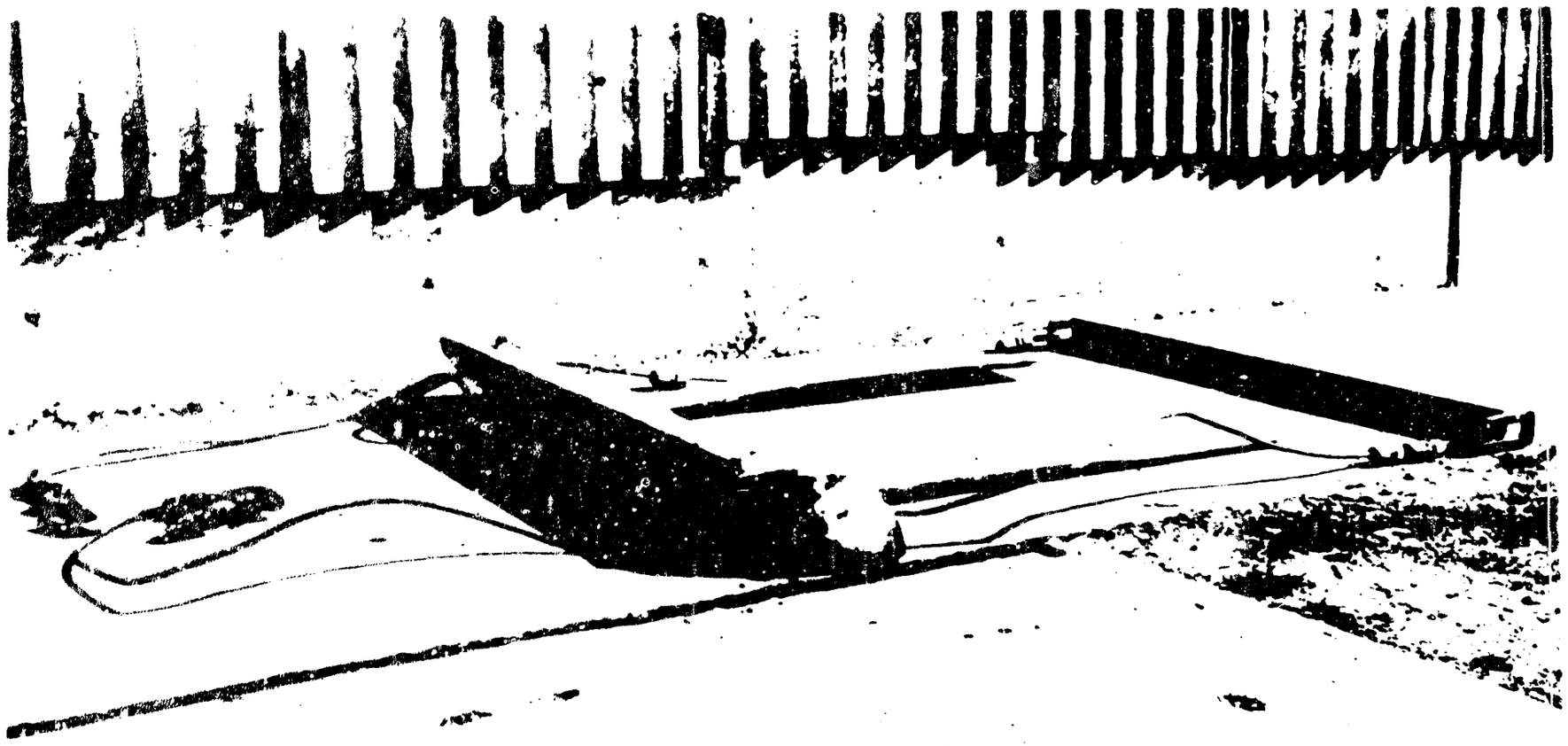
Each pallet shall be tested for its capability of being dragged over earth by toboggans of both the finger type and the solid bottom type for a distance of at least 300 feet while under a uniform load of approximately 3,500 lbs.

This pallet test is necessary in order that applicability for such movement under adverse conditions may be demonstrated.

TEST CONDITIONS

Palletized loads weighing 3,500 lbs. were steel strapped to both types of pallets and the pallets were loaded upon the toboggans. Two types of toboggans were used as follows:

1) Fork Type Pallet Toboggan - As shown by Photo 67-68, Page 65. This pallet toboggan consists of an upturned steel prow 54" wide, to which two steel runners are attached, a steel channel rear towing bar, and two towing cables, the total weighing 125 lbs. This toboggan was designed originally for the Navy Standard Wood Pallet and is loaded by inserting the runners by hand as far as possible into the 6" side spaces between the bottom boards of the standard pallet. The rear towing bar is then lifted over the load and placed against the rear of the pallet. The towing cables are attached to the prime mover and as the prime mover moves forward, the pallet load is drawn into position onto the prow of the toboggan. To remove the toboggan from the pallet the towing cables are slackened permitting the raising of the rear towing bar over the load and placed on the load above the prow. Then as the prime mover is moved forward, the toboggan is drawn from beneath the pallet. This type of pallet



FORK TYPE PALLET TOBOGGAN

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-68 PAGE 65

toboggan is shown loaded in the right hand side of Photo 40-7, Page 67.

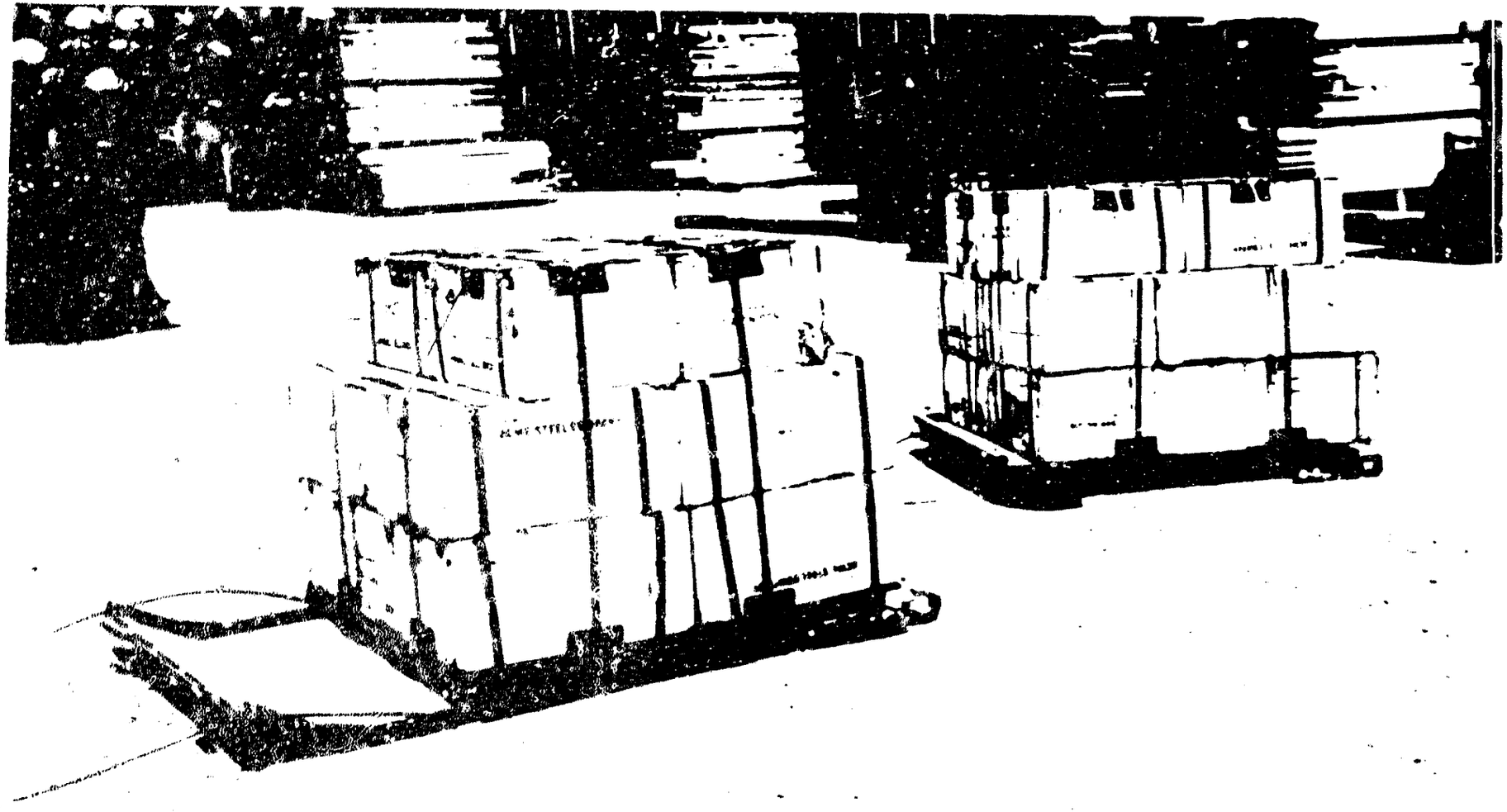
As indicated by Photo 67-75, Page 68, the Solid Bottom Toboggan consists of a solid bottom steel sheet of 16 guage (.06" thickness), 5 feet 9 inches long by 4 feet 1½ inches wide with 1½"x1½"x1/8" angle iron along the sides. A loading bar is attached to two towing cables. This toboggan weighs 135 pounds. The toboggan is normally loaded by inserting the rear end of the toboggan under the forward end of the pallet, the loading bar is lifted back over the load and placed against the rear of the pallet. The towing cables are then attached to the prime mover and as the prime mover moves forward the pallet is drawn onto the toboggan. Two stops located on both sides of the rear end of the toboggan keep the loading bar from drawing the load too far forward. In order to unload, the towing cables are slackened permitting the raising of the loading bar over the pallet and placing against the forward end of the pallet. Then as the prime mover moves forward, the loading bar forces the pallet off the toboggan.

Both types of pallets were loaded on the toboggans and were subjected to test runs over the following ground conditions:

1) A 300 ft. run over a level course gravel road,

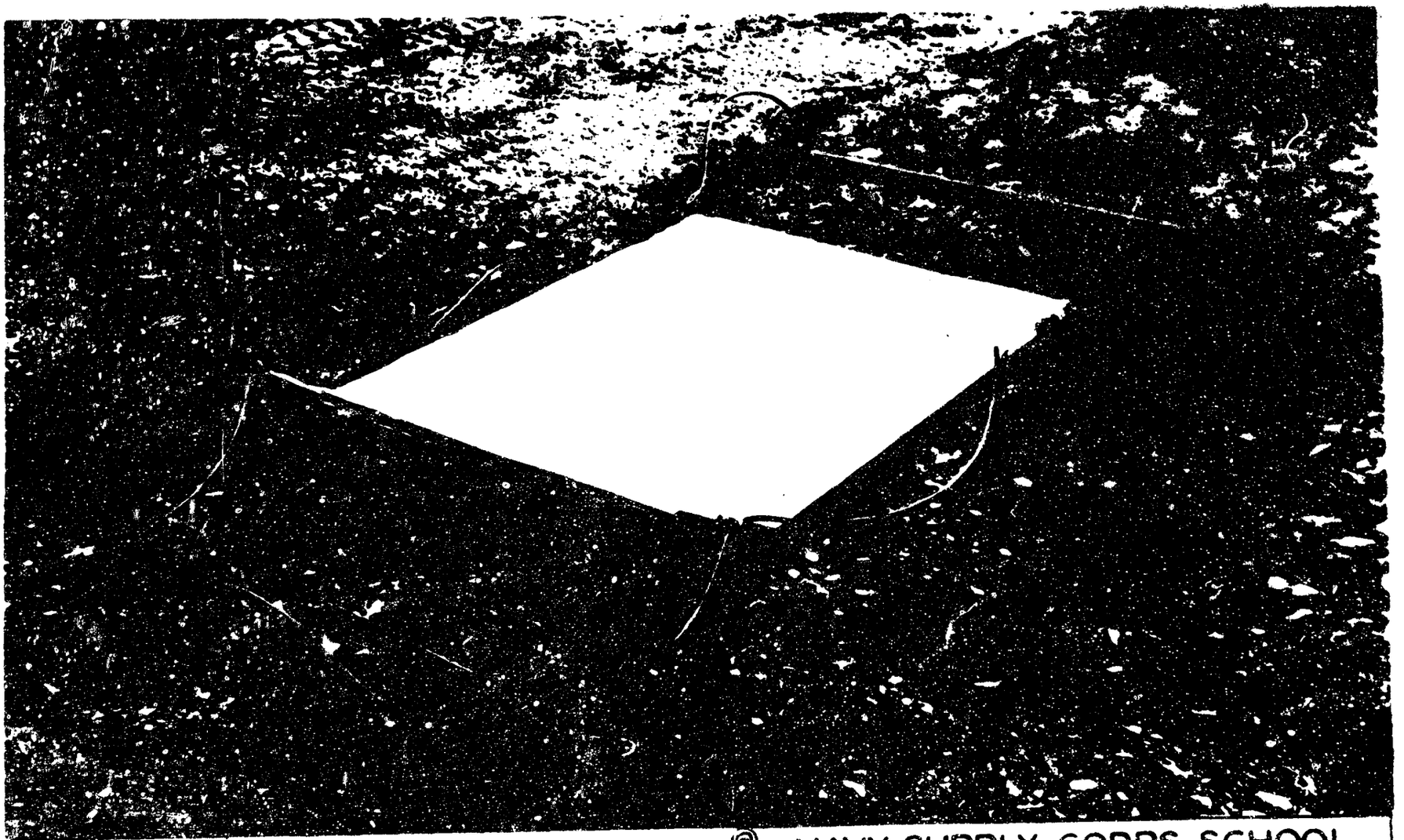
2) A 1500 ft. run over a sand and loose dirt road, including a level sand beach of approximately 150 feet and a 30 degree ten foot high slope,

3) An 1100 foot test course of varying slopes and inclinations composed of brush, logs, tall grass, stones up to 12 inches in diameter and wash boards. This course also included several ditches running transversely about 3 ft deep and 4 ft wide, a sharp slope about 3 ft high, 3 right angle turns and a 300 ft length of cinder road.



ARRANGEMENT OF STEEL WIRE PALLETS LOADED WITH
3,500 LBS. OF BEER TYPE OF TOBOGGANS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 40-7 PAGE 67



SOLID BOTTOM TYPE TOBOGGAN

(PHOTO FURNISHED BY MATL'S HANDLING LAB. HINGHAM, MASS.)

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-75 PAGE 68

RESULTS

Considerable difficulty was experienced in attempting to load the Steel Wire Pallets on the solid bottom type toboggan. The side edges of the boxed load, overhanging the pallet by approximately 3/8" would catch on the top of the leading bar stops of the toboggan and would prevent further loading. Much time was consumed in exactly lining up the load to overcome this situation. In this respect the toboggan is at fault and not the pallet.

The pallet bottom members of .264" dia. wires at right angles to the 3" wide plates did not permit the solid toboggan to slide under the pallet when the towing cables were pulled forward. When the loading bar attempted to push the pallet forward these cross wires would jam against the edge of the toboggan and prohibit the sliding of the toboggan under the pallet. After failure of several attempts to load the toboggan by this method the pallets were lifted by fork truck and lowered onto the toboggan. No difficulty of such nature was experienced when loading the finger type toboggan. Photo #40-7, Page 67 indicated the Steel Wire Pallet. Rolled Expanded Metal Deck loaded on the Solid Bottom toboggan in the foreground and the Steel Wire Pallet (Fibreboard Deck) loaded on the Fork type toboggan in the background. Both pallets were loaded with 3500 lbs of material. At the completion of the 300 ft run over the coarse gravel road the solid bottom toboggan was worn through in areas where the load was transmitted through the vertical support wires of the pallet. Photo #40-5, Page 70, indicates the type of ground over which the toboggan was pulled and also the condition of the pallet upon completion of this test run. Chalk circled areas indicate either holes worn clear through the toboggan or almost through. Where toboggan was entirely worn through, the bottom wires of the pallet

CONDITION OF SOLID BOTTOM TOBOGGAN AFTER DRAGGING STEEL WIRE PALLET LOADED WITH 3,500 LBS. OVER 300 FEET OF COARSE GRAVEL ROAD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 40-5 PAGE 70

were of course submitted to abrasive action. The abrasive nature of this type of surface is clearly illustrated also by the innumerable scratches appearing on the underside of the toboggan, some of which are quite deep.

The Fork type toboggan at the conclusion of this test run showed results of abrasive action but this type of toboggan could stand considerably more of such punishment than could the solid bottom toboggan due to the increased thickness of the bottom.

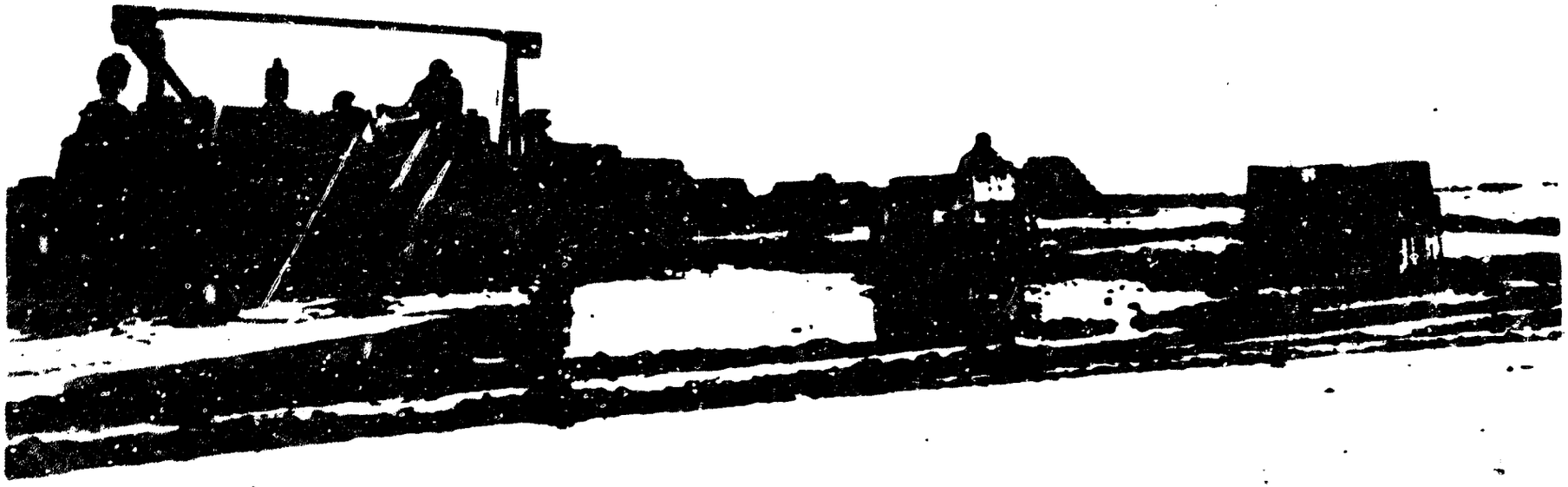
Utilizing the same loads and the same toboggans the next test was conducted over 1500 ft of sand, loose dirt, and sandy beach. The start of this test is shown in Photo #42-2, Page 72. Photo #42-5, Page 73 was taken midway through this test with the toboggans as near to the water's edge as possible without bogging down the towing caterpillar tractor. It will be noted in Photo #42-5, Page 73 that a considerable quantity of sand had piled up in front of the second toboggan which was of the fork type. Preliminary ideas were that this would be a disadvantage due to the increased drag but practical experience proved this to be a decided advantage when moving over rough terrain. Under such conditions when a large rock or block of concrete or other obstruction was encountered directly in the path of the toboggan it was found that a portion of the sand or earth in front of the toboggan would fill in around the obstruction and such fill would enable the pallet to pass over the obstruction with very little difficulty. Photo #42-1, Page 74 shows water edge conditions and turn radius with pallets on toboggans. Photo #42-7, Page 75 indicates toboggans on grade leading from beach. During the 1500 ft run over the sand beach the prow of the solid toboggan flattened out and the loading bar bent the rear of the toboggan up due to the

STEEL WIRE PALLETS BEING DRAGGED IN TANDEM ON TOBOGGANS OVER TEST COURSE OF SAND AND LOOSE DIRT.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 42-2 PAGE 72

[illegible] OF [illegible] TOWING OF STEEL WIRE PALLETS AT WATERS EDGE OF SANDY BEACH.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 62-5



TOBOGGANS IN TANDEM MAKING A 90° TURN CARRYING STEEL WIRE PALLETS AT WATERS EDGE OF SANDY BEACH.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-1 PAGE. 74

TORPEDOAL TOWING OF STEEL WIRE PALLETS AT THE START OF AN INCLINE LEADING FROM A SANDY BEACH.

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TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-7 PAGE 75

load being slightly forward of the loading bar. This failure was strictly a toboggan failure and was in no way the fault of the pallet. No appreciable damage to the pallets resulted from this run.

The final tests on the Steel Wire Pallets loaded on the toboggans were conducted over the 1100 ft rough course. A portion of which is shown by Photo 51-5, Page 77. This course was the same course used for Test #7 (Towing Test-Unsupported) and typical pictures illustrating such course may be observed in Photos 51-7, Page 51, Photo 51-10, Page 55, Photo 51-11, Page 56, Photo 51-14, Page 60, and Photo 51-24, Page 61, for such test. Both pallets completed test course #3 without serious damage to the pallet construction and these pallets appear satisfactory for such use. On this test run, however it was found that the solid bottom toboggan failed by having the inclined prow flatten out in the same manner as that observed on the previous run. It was also found that the towing bars of both toboggans bent slightly the rear .204" dia. vertical wires of the pallets during this run.

CONCLUSIONS

Results of this experiment indicate that the pallets under test are sufficiently designed in strength requirements to perform their function under the toboggan method of transportation for distances of at least 3000 ft. No appreciable damage was discernable upon close inspection after such travel and it appears pallets would be satisfactory over considerably longer distances. It is believed, however, that a considerable number of changes could be made in the toboggans to improve operation and to provide for contingencies possible in operation over rough terrain. Difficulties with toboggans were confirmed which were listed in previous tests of toboggans by the

[illegible]

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PHOTO NEG. NO. 51-5 PAGE 77

Marine Corps in the Test Report #512 (Pallet Toboggans, Lifting Frames, and Pallets) of the Marine Corps Equipment Board, Marine Barracks, Quantico, Virginia, dated 12 March 1947.

Both types of toboggans were specifically designed for the Navy Standard Wood Pallet where the practically uniform bottom bearing area of the pallet gives support to the toboggan. Such support is not obtained when the Steel Wire Type Pallet is loaded on the toboggan since the load is transmitted primarily through the vertical .264" support wires separating the top from the bottom of the pallet. Photo 40-5, Page 70 indicates one result of such transmittal. Continued dragging over rough terrain would tend to have solid obstructions cave in the toboggan in such areas where the toboggan bottom is not supported by the load. The prow of the solid bottom toboggan will not maintain its angle of inclination during normal operations and flattens out. Present design of such toboggans should be changed to strengthen these units for combat usage.

The design of the pallets, with one exception, appear to be satisfactory for towing on toboggans. It is recommended that the 3" wide metal strips be extended the full width of the pallet instead of merely to the first of the three wires on the ends of the pallets. Such plates should also be placed on the extreme bottom of the pallet instead of above the bottom wires since considerable difficulty is encountered when trying to load wire type pallets upon the solid bottom toboggan. This difficulty is caused by the fouling of the bottom wires upon the edge of the toboggan when the pallet is pulled aboard the toboggan in a direction parallel to the 3" wide plates. Such bottom wires are at right angles to the edge of the toboggan and successively jam against such edge when the pallet is hauled aboard.

Provisions must be made in the design of the pallet so that it may be loaded aboard a toboggan from any of the four sides of the pallet without fouling difficulty.

Using the present solid bottom toboggan it was necessary to load the wire type pallets by placing aboard the toboggan using a fork lift truck. This loading method defeats one of the primary functions of a toboggan used for combat purposes.

TEST #9 - ASSEMBLY STRENGTH TEST

STANDARD TEST PROCEDURE

Each pallet shall be tested for handling under awkward conditions. One of these tests shall consist of an upside down test wherein a load of 3,500 pounds secured to a pallet by strapping shall be carried in an upside down position for a horizontal distance of 20 feet.

The purpose of this test is to demonstrate the suitability of a pallet to withstand severe conditions which are occasionally encountered. It also provides information on the strength of the pallet and possible points of pallet failure.

TEST CONDITIONS

Both types of Steel Wire Pallets were loaded with 3,500 lbs of steel material in boxes, and were wire strapped. The pallets were then submitted to the following conditions of awkward handling to determine strength of assemoly:

a) Loaded pallets were rolled over and were then picked bottom side up by fork truck and moved a horizontal distance of 20 ft.

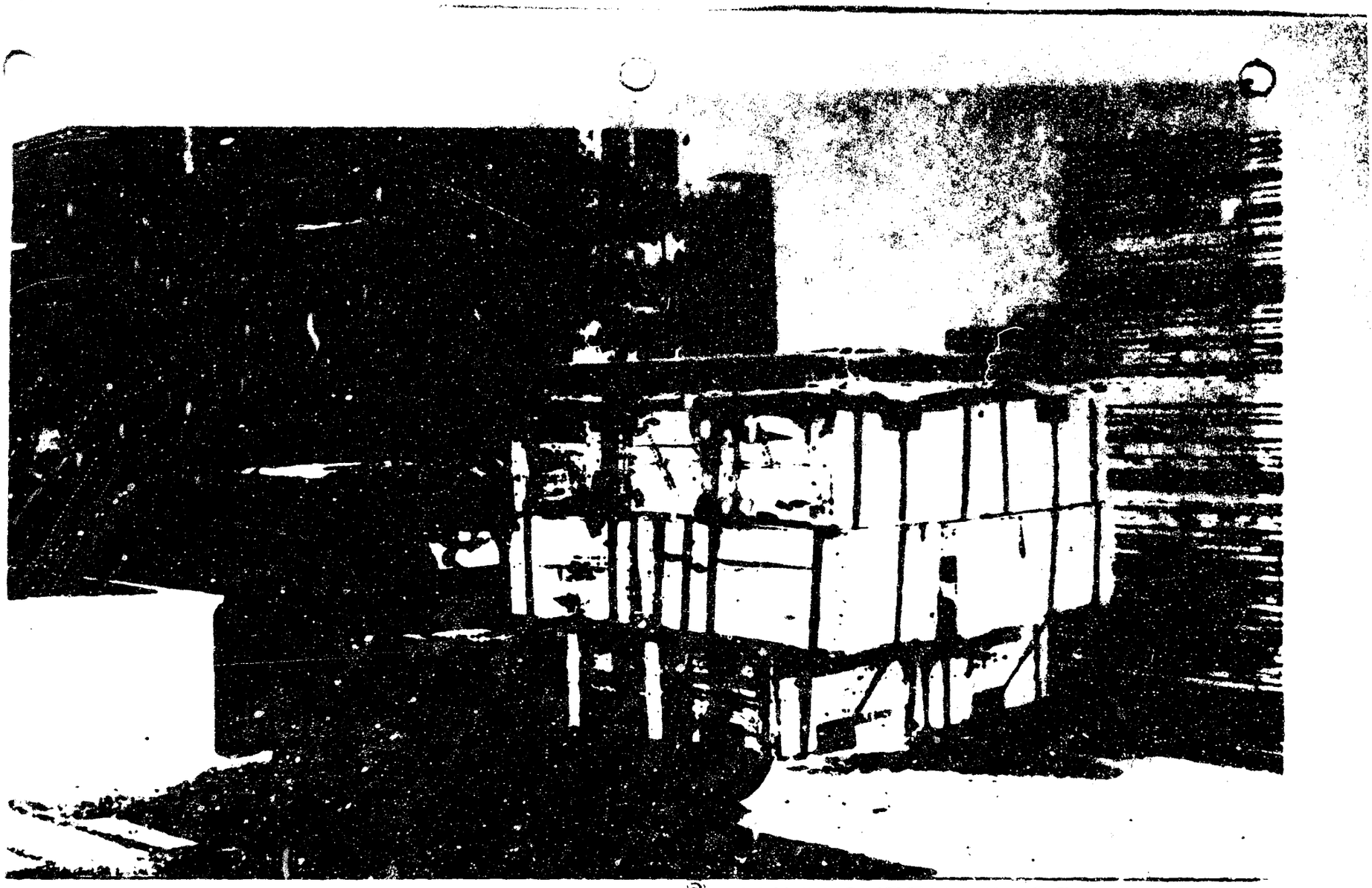
b) Loaded pallets were maneuvered into different positions by inserting the forks of the fork lift truck under the corner of the pallet and inching the pallet along. This procedure was also followed with pallets loaded with odd shape equipment in order to eliminate the reinforcement provided the deck by a flat load.

c) Loaded pallets were simulated being pushed into final position by means of the forks of a fork truck. TheStandard Navy Wood Pallet was subjected to the same conditions of this test to obtain comparative results.

RESULTS

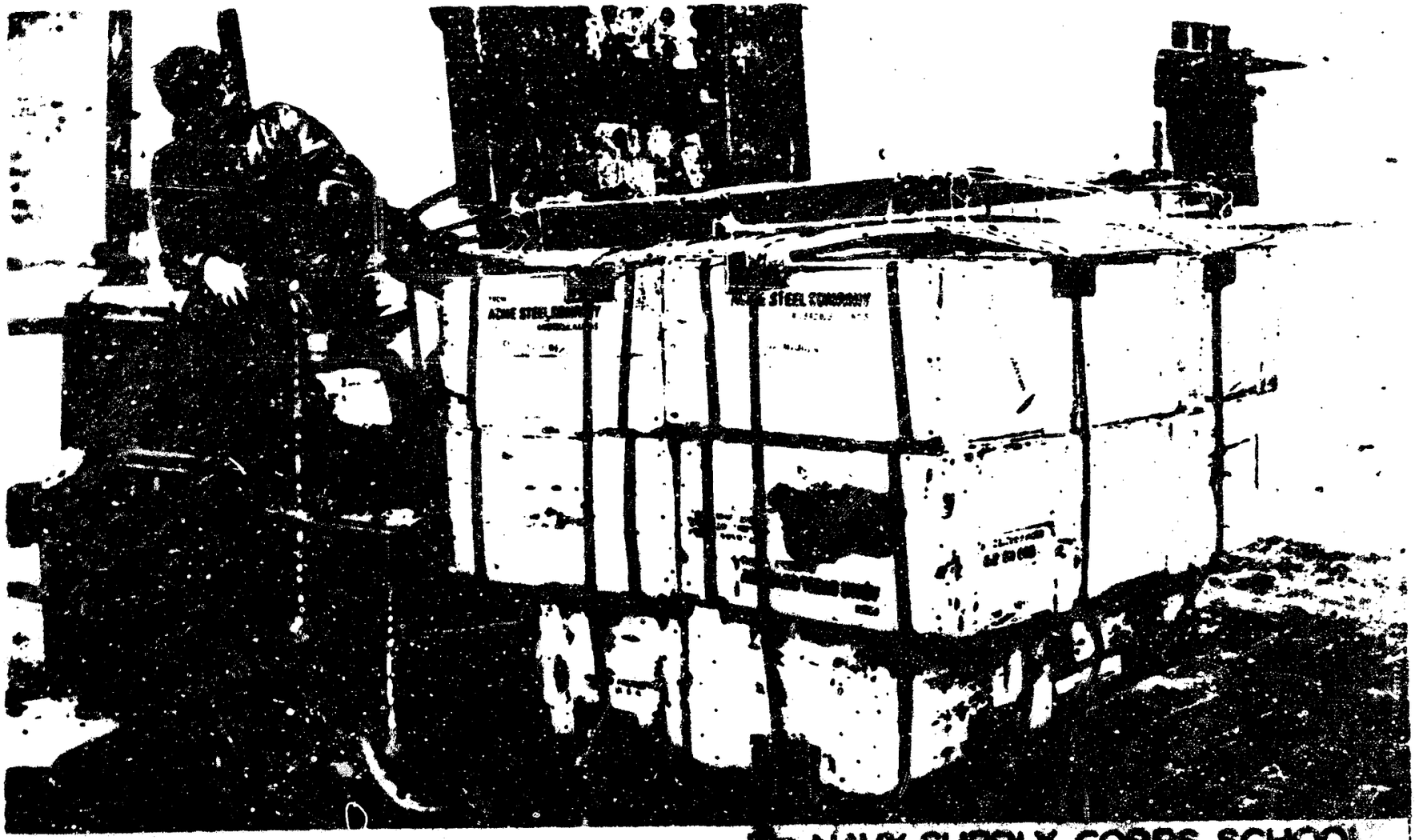
Both types of Steel Wire Pallets reacted satisfactorily when submitted to the upside down test. As indicated by Photos 40-0, Page 82 and 42-12, Page 83, both the bottom wires and the 3" wide steel plates of the bottom of the pallets showed slight bending due to the suspended load of 3,500 lbs. However, when returned to normal position the bottom structure very closely returned to its original shape. No damage to the pallet decks resulted from the pickup. The welds bonding the deck of the pallet to its support did not break apart. The pallets were carried in the upside down position for a distance of 20 feet.

When the forks of a fork truck were used to tilt up one end of the Steel Wire Pallet (Fibreboard Deck) with the pallet loaded with a finger type pallet toboggan weighing 125 lbs, and an endeavor made to inch the pallet forward and backward, it was found that the forks pierced the deck of the pallet. Such piercing was due to the non-uniform distribution of the load which did not permit reinforcing of the pallet deck by the load. The results of such test are illustrated by Photo 50-1, Page 84. Such method of movement occurs in warehouse materials handling. With both types of Steel Wire Pallets submitted to such tests it was found that the pallets with a 3,500 lb load were easily inched along over a concrete warehouse floor and although the underneath structure of the pallets tended to dig in when pushed forward, the physical structure was not impaired. If, however, the forks of the fork truck are used to push against the vertical support wires, separating the bottom from the top of the pallet, such wires were found to bend as indicated by the left pallet corner shown by



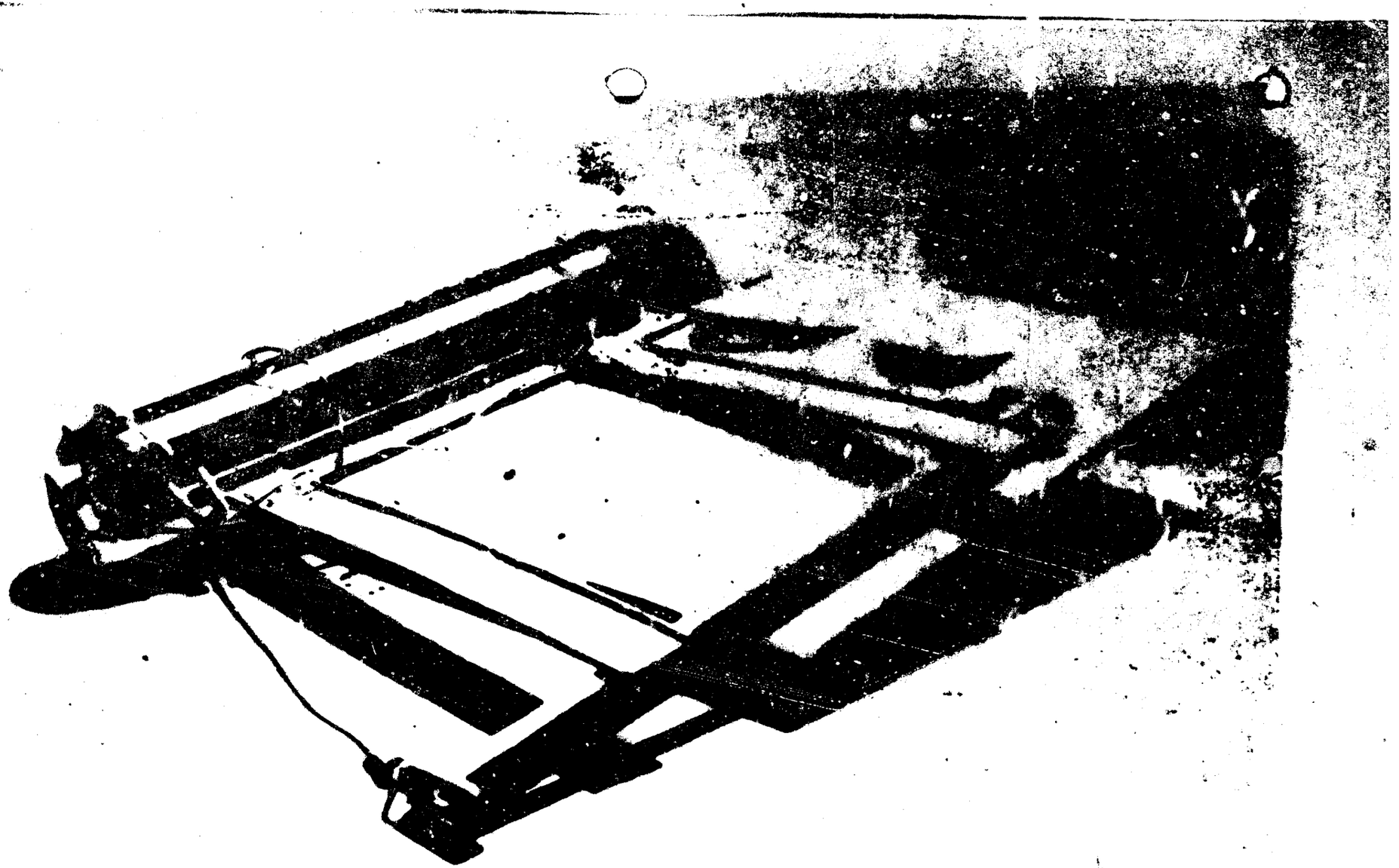
3,500 LB. LOAL BEING SUSPENDED FROM THE FIBRE-BOARD DECK PALLET FOR TEST# 9 ASSEMBLY STRENGHT TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 40-0 PAGE 82



3,500 LB. LOAD BEING SUSPENDED FROM THE EXPAND-
ED STEEL SIDE RAILS FOR TEST 9, ASSEMBLY
SCHEDULE TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 49-12



DAMAGE TO FIBERBOARD DECK PALLET OCCURRED IN TEST/9, ASSEMBLY STRENGTH TEST. DECK ASSEMBLY FAILED DUE TO MID-UNIFORM LOAD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 50-1 PAGE 84

Photograph 42-12, Page 83. The Standard Navy Wood Pallet was able to pass all conditions of this test without apparent signs of damage to its structure.

CONCLUSIONS

The Steel Wire Pallet (Rolled Expanded Metal Deck) is satisfactory for awkward handling conditions.

The Steel Wire Pallet (Fibreboard Deck) is not satisfactory for awkward handling conditions due to rupture of the pallet deck under certain handling conditions.

The underneath structure of both types of pallets are similar and being formed mainly of .264" dia. steel wires, have the flexibility and elasticity to absorb shock, permitting the return of the physical structure to original shape if the shock load is uniformly distributed. When concentrated stress is applied to individual members of the underneath structure, such members may bend, but usually such bending is not severely detrimental to pallet operations.

TEST #10 - RACKING TEST

STANDARD TEST PROCEDURE

Each pallet is to be dropped in an unloaded condition directly on one corner, on the flat, and also upon one side, from a height of ten feet to a concrete floor in order to determine the ability of the pallet to withstand racking.

The purpose of this test is to determine the resistance of each pallet to rough handling. It has been found that a considerable portion of damage occurring to pallets is the result of manual handling of the empty pallets. When a pallet falls or is dropped from a stack of empties it invariably drops on its corner and racks, or tends to distort from a rectangular to an oblique parallelogram figure. If a pallet is not designed to safely absorb such shocks, maintenance costs may be high. Occurrence of such conditions are common in stevedoring and general supply depot work. This test is devised to give an indication of reaction to such rough handling.

TEST CONDITIONS

One empty pallet of each type was placed on top of a palletized tier in a warehouse having a concrete floor. This tier was ten feet high. The pallets were dropped from the top of the tier to the concrete floor. A total of three drops was accomplished on each type pallet. The pallets were positioned so as to land successively on one corner, on the flat, and on one side. The amount of rack was determined by the difference in measurements of the pallet diagonal dimensions. Such dimensions were obtained both before and after the drop. In order to obtain a basis of comparison, a Standard 48" x 48" Navy Wood Pallet was subjected to the same tests.

RESULTS

Test results indicated that when the Steel Wire Pallet (Rolled Expanded Metal Deck) was dropped on one corner, the decking at the corner bent over the 3" overhang distance to the vertical supports. The 1" "U" edging also broke open at the point of impact but welds did not part. This damage is of a minor nature. There was no appreciable difference in the diagonal measurements before and after the drop. On the other two drops this pallet showed no damage.

When the Steel Wire Pallet (Fibreboard Deck) was dropped on one corner, this corner bent over the 3" distance of the overhang of the deck to the vertical supports. The top deck in the general area of impact also cracked and broke up. On the opposite side of the point of impact the Fibreboard Deck pulled out from the "U" edging a maximum distance of 1/4". The diagonal measurements of the pallet showed a difference of 3/4" after this drop test. When this pallet was dropped on one side, the "U" edging supporting this side curled over to the deck. The Fibreboard top deck again cracked and broke at the points of impact. No damage resulted to this pallet when it was permitted to fall flat in its normal horizontal position.

When the Standard Navy Wood Pallet was dropped on its corner during these tests, a difference in diagonal measurements of 2 inches were noted after the drop. In addition, the nails of the top deck were generally loosened, some being exposed above the top boards about one quarter of an inch. When this pallet was dropped on its side and in a flat position, no damage resulted.

CONCLUSIONS

The results of precribed tests indicate the Steel Wire Pallet (Rolled Expanded Metal Deck) does satisfactorily meet requirements. It

resists racking action better than does the Standard Navy Wood Pallet and such damage as does occur is of a minor nature.

The results of such tests also indicate that the Steel Wire Pallet (Fibreboard Deck) is not satisfactory for rough handling conditions which would induce pallet racking. Under such conditions the pallet deck breaks up and since no support is furnished the underneath structure of the pallet by the decking, deformation of the pallet is found to occur.

Although the Steel Wire Pallet (Rolled Expanded Metal Deck) will withstand normal rough treatment it will not stand concentrated abuse. The understructure and the vertical supports of the pallet are composed of single wires for the most part and these are subject to bending upon the application of direct strain which is not distributed over an area of the pallet. It must be remembered that in this pallet; design for punishment by concentrated strain has been sacrificed to some extent to gain a more important saving in weight. The result in the case of the Steel Wire Pallet (Rolled Expanded Metal Deck) is a very acceptable pallet which will stand severe general handling as is encountered in ordinary amphibious operations, but which is not intended to withstand intentional damage by forces concentrated upon any one small section of the pallet.

TEST #11 - MOVEMENT TEST

STANDARD TEST PROCEDURE

Each pallet shall be tested for movement by roller conveyors, pipe rollers, and skid rails when loaded with approximately 3,500 lbs. A report is to be made in each instance.

Tests shall also indicate the possibility of moving a pallet with load of 3,500 lbs by inserting the forks of a fork lift truck under a corner of the pallet and inching the pallet into position similar to such a condition which might be encountered in loading a box car.

The purpose of these tests is to determine if each submitted pallet is capable of being readily moved by emergency means when regular equipment is not available.

TEST CONDITIONS

A load of 2,150 lbs was placed on each of the two types of Steel Wire Pallets and were subject to a series of movement operations commonly used when regular materials handling equipment is not available or where secondary means of pallet transfer is necessary. A lighter load than the recommended 3,500 lb. load was utilized as difficulty was anticipated with these tests. Arrangements for test conditions were as follows:

1) Movement by Roller Conveyor

Two lengths of 15" wide standard roller conveyor were placed adjacent to each other upon a warehouse floor providing a total length of conveyor of 20 feet. A loaded pallet was placed upon one end of this conveyor line and was pushed to the opposite end by manual effort. Each pallet was moved [illegible] the conveyor, being turned 90 degrees upon completion of the first movement.

2) Movement by Roller Bars - A loaded pallet was placed upon rollers and pushed manually a distance of 20 feet with a minimum of two wood rollers supporting the loaded pallet at any one time. Four standard wood rollers, 6" diameter x 6 feet length of the type used by Naval activities for such purposes, were utilized in this test. The test was conducted upon a cement floor in a warehouse. Each pallet was moved twice upon the rollers, being turned 90 degrees upon the completion of the first movement.

3) Movement by Skids - A pair of 6"x6"x15' long wood stringers were placed horizontally upon a cement floor and spaced to accomodate a pallet. A loaded pallet of each type was placed successively upon one end of the "skid" arrangement and by means of a tow rope passed around the aft end of the pallet it was dragged over the total length of the wood skids.

4) A loaded pallet of each type was made to move along a floor by means of an inching procedure. This consisted of a fork truck picking up one end of the pallet and moving the pallet along by a repetitive lift, move, and drop procedure. In this test also, as well as in test conditions #1, #2, and #3 of this movement test; a method was followed to determine acceptable directions of travel afforded by the understructure bearing surface design of the pallets, by placing different sides forward during conductance of tests.

RESULTS

It was found by test that very little difference was encountered in results due to the difference of pallet deck construction. The understructure of such pallets are practically identical. When a loaded pallet was placed upon the roller conveyors; a considerable amount of manual effort was required by two men to move the pallet

along the conveyor and it was found that interference developed between the understructure of the pallet and the conveyor. This condition was more pronounced when the loaded pallet was positioned on the conveyor with the 3" wide ribbed formed bottom plates moving at right angles to the rollers. It was found that in such direction of pallet movement, the bottom bearing .264" dia. wires would drop between the rollers and bear against the channel iron frame sides of the conveyors, and such contact resulted in a severe restriction of travel. This condition is similar to that indicated by Photo #107-0, Page 92. When the pallet was forced along the conveyor the alternate raising and dropping of the wires between the rollers resulted in a considerable amount of pallet vibration and the expenditure of considerable force to obtain movement.

When movement by wood rollers was attempted it was found that when the 3" wide ribbed plates on the bottom of the pallet were placed at right angles to the wood rollers, such plates showed a tendency to deflect but movement could be made although difficulty was experienced in inserting new rollers at the forward end of the pallet. When such pallet bottom plates were placed parallel to the wood rollers, the full weight of the loaded pallet was born by the cross wires which were not sufficiently rigid to withstand the load and failure of the pallet resulted as indicated by Photo #104-0, Page 91.

When the "skid" method of pallet movement was attempted, difficulty was experienced in that the understructure of the pallets tended to dig into the wood when pulled forward. This resulted in resistance and pallet vibration. Such movements could be made, however, with only a slight deflection of the understructure of the pallet.

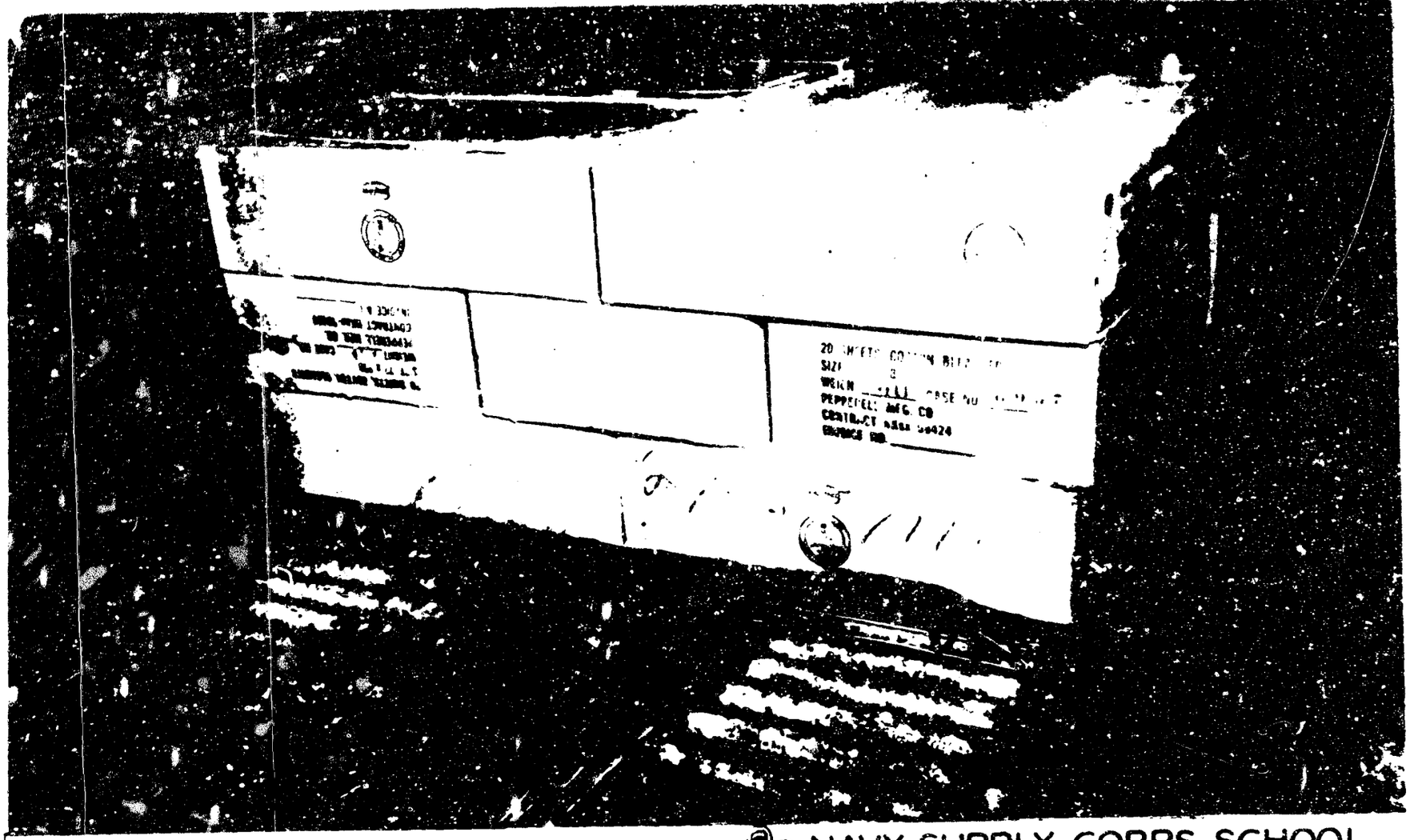
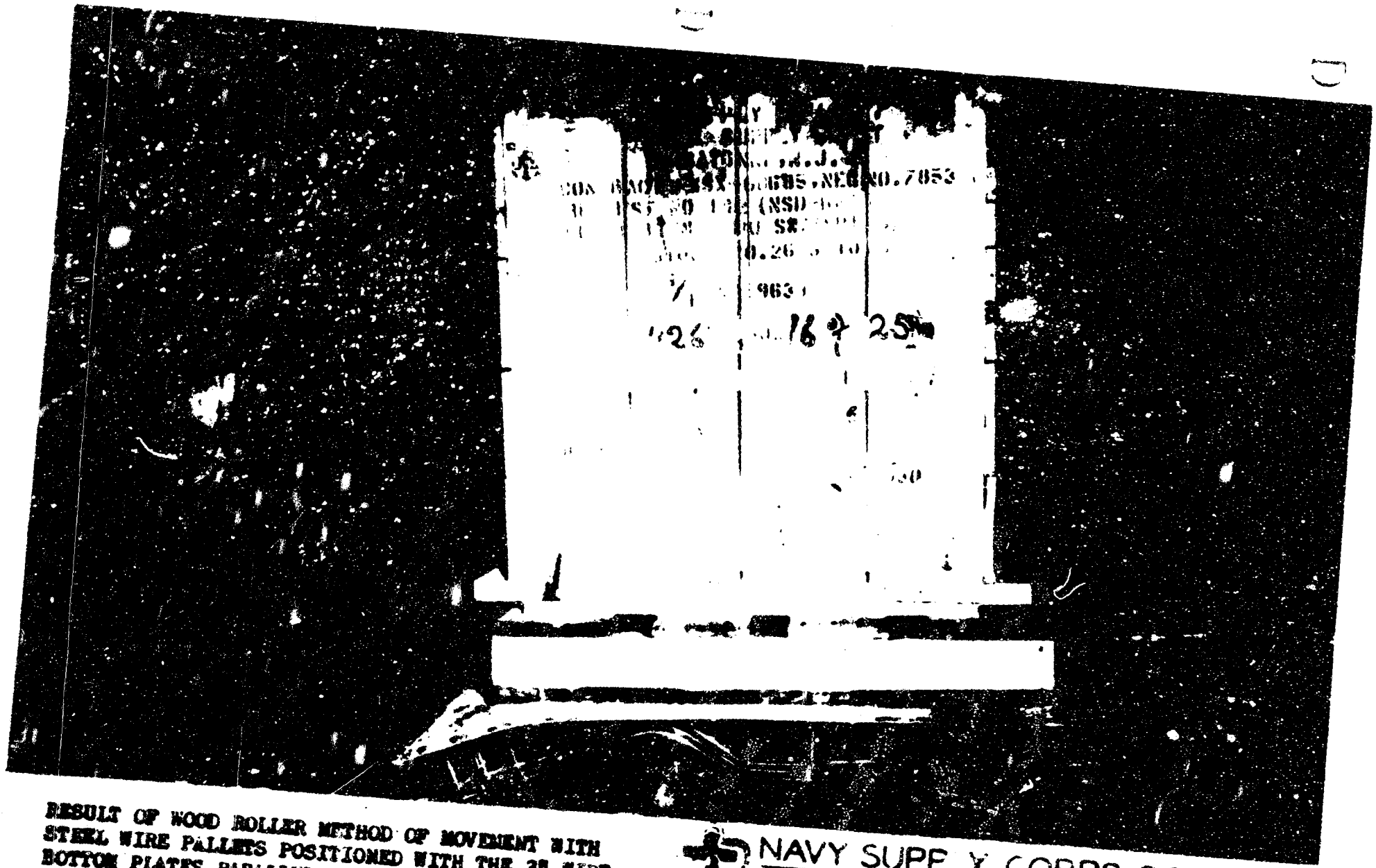


ILLUSTRATION OF ROLLER CONVEYOR METHOD OF MOVEMENT WITH STEEL WIRE PALLETS POSITIONED WITH THE 3" WIDE BOTTOM PLATES AT RIGHT ANGLE TO THE ROLLERS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 107-0 PAGE 92



RESULT OF WOOD ROLLER METHOD OF MOVEMENT WITH STEEL WIRE PALLETS POSITIONED WITH THE 3" WIDE BOTTOM PLATES PARALLEL TO THE WOOD ROLLERS. PALLET DID NOT PASS THIS TEST.

When the pallet was moved by "inching" it was found that such could be accomplished in a satisfactory manner.

CONCLUSIONS

Both designs of Steel Wire Pallets are not satisfactory for movement by the emergency methods indicated by this test. Although in each case, with one exception, it is possible to move pallets by such means, such can only be accomplished by the expenditure of considerable effort. The bottom surface of these pallets is considerably inferior to the Standard Navy Wood Pallet for the purposes of this Movement Test. Due to the fact these pallets are being tested for use as combat pallets, and that such use would require completely satisfactory movements by the emergency means indicated, the deficiency of the pallets indicated by this test is of utmost importance.

TEST #12 - WATER ABSORPTION & RETENTION TEST

STANDARD TEST PROCEDURE

Each pallet shall be tested for the rate of water absorption and the effect of such absorption upon the physical characteristics of the pallet. The test shall consist of lightly spraying each pallet at the rate of approximately one gallon per minute for a period of 15 minute intervals. Weights shall be measured at the end of 15 minutes and the test continued until the rate of absorption becomes negligible. Pertinent information regarding the condition of the pallet at the end of each 15 minute interval shall be recorded. Observations shall include comments on the degree of water retention on the top surface of the pallets.

Pallets as used by the Navy may be subjected to the action of rain, spray, or high humidity conditions, and it is believed desirable to have an indication of the effects of moisture upon the pallets and of the degree of the retention of moisture.

TEST CONDITIONS

One empty pallet of each type was weighed previous to the start of the test. Pallets were then subjected to a fine spray utilizing an ordinary garden hose with lawn sprinkling attachment simulating a light raining condition. The spray was varied in direction to reach all portions of the pallet. After spraying for a period of 15 minutes the pallets were inspected and weighed to determine change in weight due to water collection and absorption properties. Spraying was continued for 15 minute intervals until differences in weight were negligible at the end of such periods.

RESULTS

The weights of the pallets before spraying with water were found to be as follows:

Steel Wire Pallet (Fibreboard Deck - - - - 54 lbs.

Steel Wire Pallet (Expanded Metal Deck)- - 66½ lbs.

Standard Navy Wood Pallet - - - - - - - - - 94 lbs.

At the end of the first 15 minutes subjection to water spray the Steel Wire Pallet (Fibreboard Deck) showed an increase in weight of 1/2 lb, and the Steel Wire Pallet (Expanded Metal Deck) showed an increase in weight of 1 lb. At the end of the second and third 15 minute spray periods there was found to be no further increase in weight.

It was observed that the pallet having the expanded metal deck showed a greater tendency to retain water drops upon its structure. These drops clung to the diamond mesh design of the pallet similar to beads of sweat. When water collected on the Fibreboard Deck pallet, the droplets would tend to combine and roll off the edges except where slightly concave areas existed.

It was further observed that both of the above pallets returned to a complete state of dryness 15 minutes after conclusion of the spraying tests. This test was conducted on a warm summer day.

At the end of the first 15 minutes of water spraying, the Standard Navy Wood Pallet weighed 97 lbs, a gain of three pounds. The next 15 minute period showed a further gain of one pound and the following period a gain of one-half pound with no further increase in weight. Total gain in weight was therefore four and one half pounds for a final weight of 98½ lbs

CONCLUSIONS

The degree of water absorption and retention of both pallets

is negligible. Such a characteristic is superior to the Standard Navy Wood Pallets wherein water absorption amounts to 4.6% and may reach a value as high as 20% under favorable conditions. The steel construction and design of the tested pallets eliminates possibilities of detrimental weight gains due to water accumulation. The Steel Wire Pallet (Rolled Expanded Metal Deck) is particularly well designed in this respect.

TEST #13 - OIL ABSORPTION TEST

STANDARD TEST PROCEDURE

Pallets are to be subjected to oil and grease applications and a record made in regard to ease of cleaning, degree of absorption, and possible changes in physical strength and efficient load carrying characteristics due to oil absorption. Observations are to include the degree of retention of odor by the pallets, if any, in order to avoid odor contamination of succeeding loads; for example, the contamination of a later load of butter by a previous load of fish.

It has been found that pallets may be exposed in actual practice to oil and grease from overhead cranes, or other materials handling equipment and also in some cases to spillage of load contents or absorption of odorous oils. It is believed advisable to indicate the degree of penetration in such cases to show the possible degree of contamination to later loads and also to determine if structural harm may be done to the pallet. It is also desirable to know in such cases if cleanliness may be quickly regained with little loss of time or effort.

TEST CONDITIONS

Drops of oil were applied to the deck and understructure of both types of pallets by means of a hand operated oil can. The degree of oil penetration was observed and an attempt made to wipe the pallet clean with dry rags.

RESULTS

On the Steel Wire Pallet (Rolled Expanded Metal Deck) it was found that the oil droplets were not absorbed and were easily removed from all parts of the pallet by rubbing with a waste rag.

On the Steel Wire Pallet(Fibreboard Deck) it was found that normally there was no oil absorption and the pallet was easily wiped clean. If, however, the Fibreboard Deck were broken or cracked, it was found that oil would rapidly penetrate into the broken portion of the decking where the deck was not protected by the aluminum paint. Scratches upon the pallet decking also permitted absorption of oil into the Fibreboard Deck.

CONCLUSIONS

The Steel Wire Pallet (Rolled Expanded Metal Deck) does not show any degree of oil absorption and is satisfactory for oil conditions as illustrated by this test.

The Steel Wire Pallet (Fibreboard Deck) does not show oil absorption as long as the deck is intact but will readily absorb oil upon marring or breaking of the deck.

TEST #14 - TEST FOR PROTECTIVE COATINGS

STANDARD TEST PROCEDURE

Each pallet shall be tested to indicate whether or not a protective coating has been applied and a report made indicating the effectiveness of such coatings where applicable. In order to secure required information each pallet shall be immersed for 12 hours daily for a period of two weeks to the action of sea water. At the end of the 12 hours immersion the pallets are to be allowed to dry for 12 hours and then again immersed. At the end of the test a report will be made indicating deterioration, such as rust, etc., and the general effectiveness of protective coatings on the pallet components.

Although the above test would at first appear to be more severe than would be indicated by practical applications, this is explained by the fact that an attempt is being made to obtain deterioration data within a relatively short period of time and consequently severe conditions must necessarily be imposed. Navy pallets are usually submitted to waterfront conditions of high humidity and salt or sea water atmosphere, and deterioration may in some cases be high if protective measures are not built into the pallet. It is believed the above test will give an indication of the protection afforded in different types of design.

TEST CONDITIONS

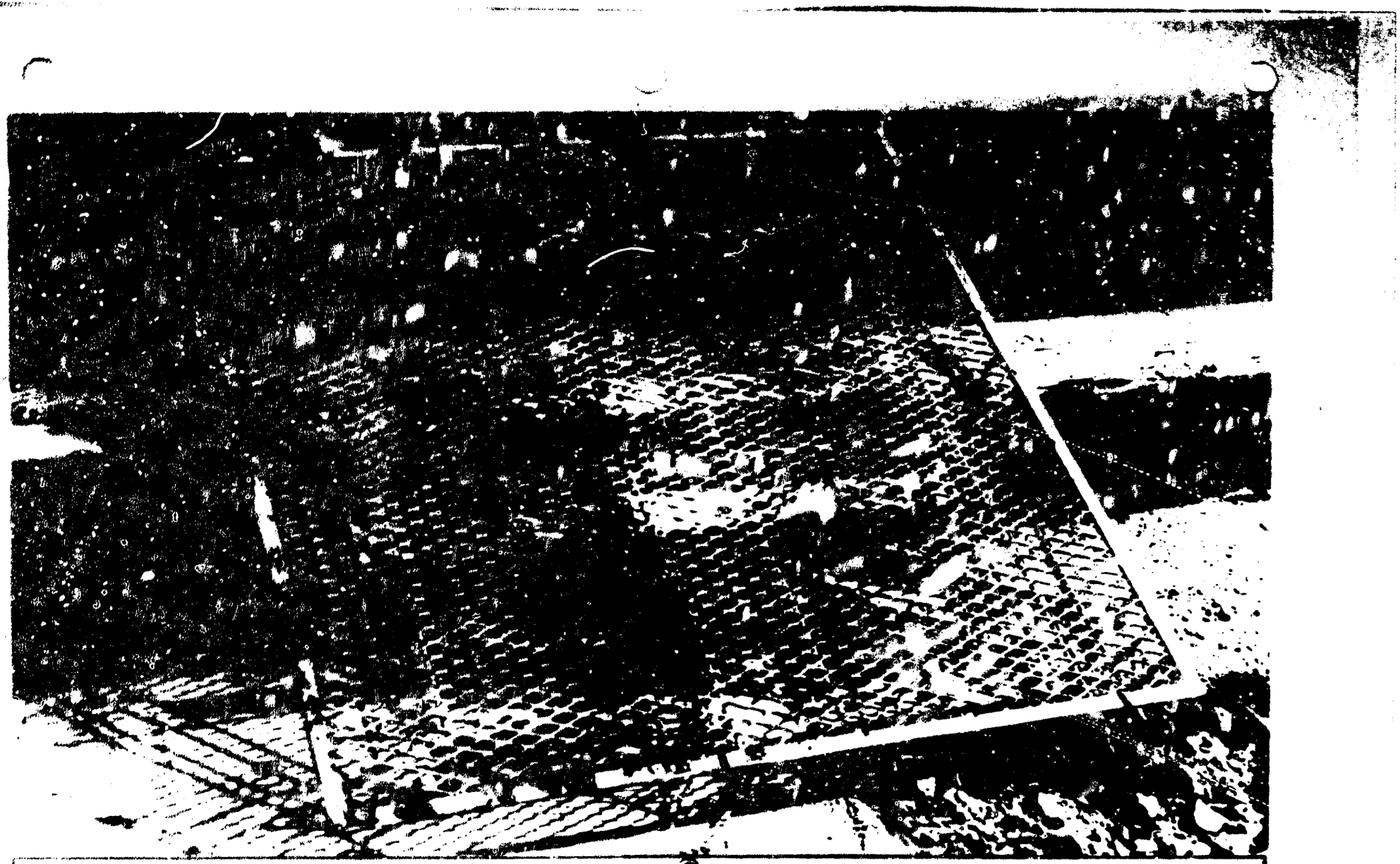
One each of the two types of steel wire pallet was secured by a tie line and dropped over a bulkhead wall until the pallet was completely immersed in the sea water of New York Harbor. At the end of a 16 hour period of salt water immersion the pallet was left to dry for a period of 8 hours. The time for immersion was above the

minimum required by the "Standard Pallet Test Procedure." It was necessary to alter immersion time from the recommended 12 hours for testing convenience. Such schedule of immersion and drying was followed for a period of one month and during this time daily observations were made regarding the protective qualities of the paint covering the pallets.

RESULTS

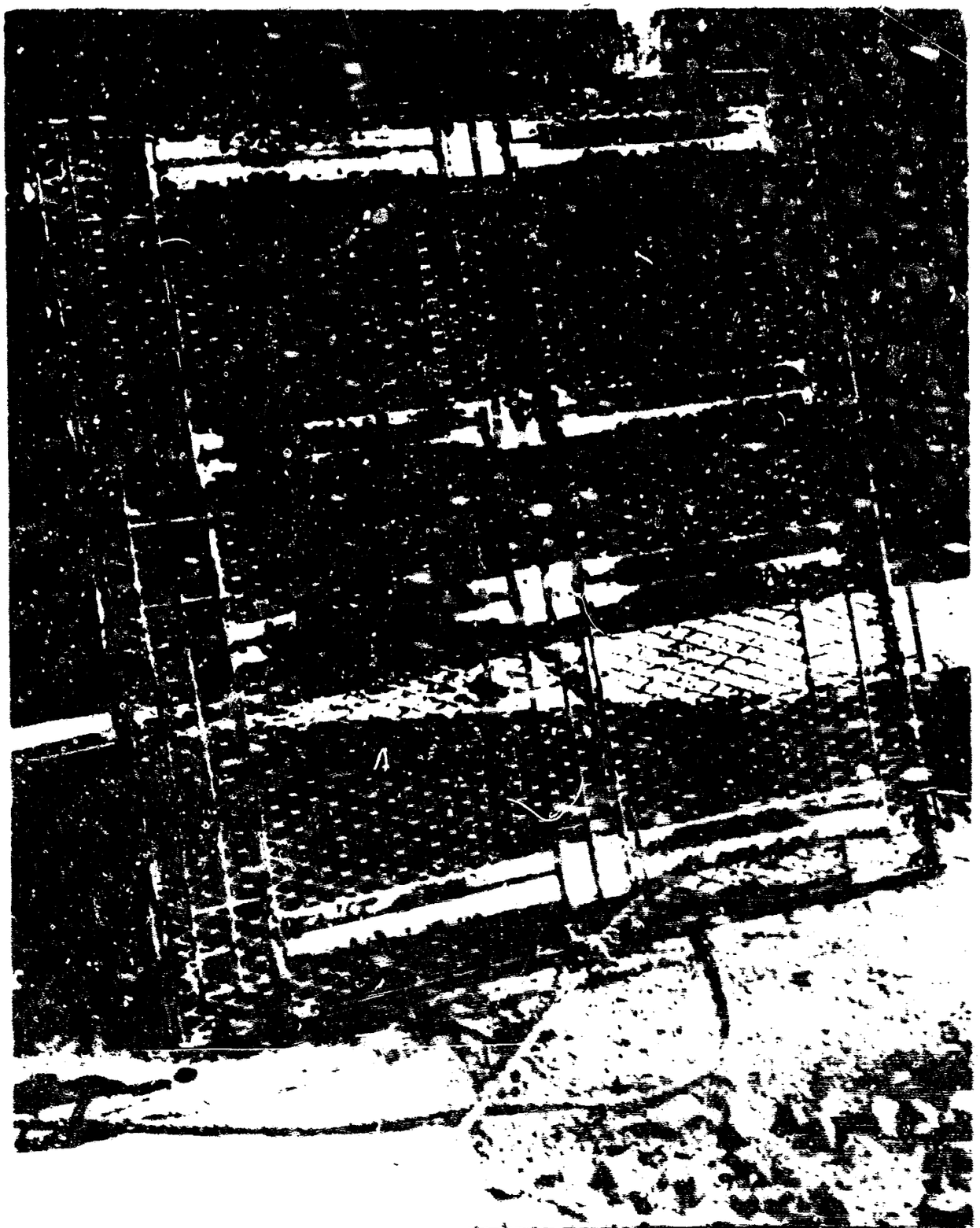
After the third day of sea water immersion, the protective coating of both types of pallets showed a blistered condition. The total number of hours of salt water immersion at this time was 56 hours. It was then observed that the blistered paint could be scraped off by a fingernail, and that salt water was found to be in contact with the steel wire under the blisters. A rusting of the pallets steel structure was also noticed in crevices not protected by paint and in uncoated portions of the "U" edging around the pallet deck. When the pallets were permitted to dry for a period of 8 hours it was found the paint blisters would dry up and the pallet would assume its original appearance. After a week of alternate immersion and drying the pallet developed a widespread rusting condition and at the end of one month's time the protective coating of the pallet had practically disappeared. Photographs 40-1, Page 102 and 40-8, Page 103, illustrate condition of a pallet after a period of one month's time of alternate wetting and drying by sea water. Paint blisters may be observed in both photos. Dark areas indicate rusting.

When the Steel Wire Pallet Fibreboard Deck was submitted to this test it was found that the deck top began to warp with immersion and that upon drying the deck top distorted into a wavy sheet, which condition was then permanent.



CONDITION OF EXPANDED METAL DECK AFTER ONE MONTHS TIME OF ALTERNATE WETTING AND DRYING BY SEA WATER

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 40-1 PAGE 102



CONDITION OF UNDERSTRUCTURE OF STEEL WIRE PALLET AFTER SEA WATER IMMERSION TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE, N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO. 40-8 PAGE 103

CONCLUSIONS

The protective coating applied to both types of Wire Pallets is not adequate for combat usage. The coating as applied appears to be sprayed aluminum paint and it is believed this has been furnished without serious thought being given to corrosive conditions which may result from combat usage. It is recommended that the manufacturer secure a suitable coating which will meet the requirements of this test. Care should be taken during application of such coating to insure complete coverage of the pallet. Locations inaccessible for painting in the completed pallet should be painted previous to the assembly process.

TEST #15 - FIRE RESISTANCE

STANDARD TEST PROCEDURE

Pallets are to be tested to determine the fire resistant qualities in each case. A gasoline blow torch flame shall be directed upon sample portions of the pallet to determine if the pallet is very readily ignitable, partially resistant, or is fire proof. Attention is to be given to the deterioration or inflammability of protective coatings, and deterioration of strength qualities.

It is not particularly desirable in most instances that pallets be completely fireproof but usually it is necessary that they be fire resistant.

A fire raising the temperature to that necessary to ignite an ordinary hard wood pallet would in all probability destroy the pallet contents and there would be no point to considerable cost to secure fireproof pallets in such cases.

It is necessary, however, to have a general idea of fire resistant qualities for proper pallet application and it is believed the above test will give such indication.

TEST CONDITIONS

One empty pallet of each type was transported to an open outside area. At such place, a flame from a hand operated gasoline blow torch was directed to different portions of the pallet. During the application of flame to each pallet, the reactions of the pallet to such test were noted.

RESULTS

The Steel Wire Pallet (Rolled Expanded Metal Deck) was proven to be entirely fireproof. The aluminum paint covering such pallets did not check, blister, or ignite.

The Steel Wire Pallet (Fibreboard Deck) was considerably fire resistant as long as the pallet deck was not broken. When the flame was directed to a broken portion of the "Fibreboard" deck, the deck caught fire and burned slowly. At the end of five minutes this fire was still burning but had not increased in rate. Such fire was easily extinguished with sand.

CONCLUSIONS

The Steel Wire Pallet (Rolled Expanded Metal Deck) is entirely fireproof.

The Steel Wire Pallet (Fibreboard Deck) is considerably fire resistant and is very difficult to burn unless the deck is in a broken condition. When ignited the pallet burns very slowly.

Both types of pallets are covered with an aluminum paint which is not affected by fire.

TEST #16 - SWEAT RESISTANCE

STANDARD TEST PROCEDURE

Each pallet shall be tested for sweat resistance, being placed in a refrigerated space at a temperature of (0°) for a period of 12 hours and then exposed in a room having a temperature of approximately (80°) and a humidity of 85%. The degree of sweating shall be observed ten minutes after being placed in the warm room.

The retention of water under sweating conditions may in some cases be important and information in this respect and in regard to effects of sudden temperature changes may be obtained from the above test.

TEST CONDITIONS

One empty dry pallet of each type was weighed and then subjected to a stowage period of more than 12 hours in a refrigerated warehouse having an inside temperature of minus [illegible] F. At the end of this period the pallets were transferred immediately to a covered outside platform of the building and allowed to condense moisture from the air for a period of 10 minutes. During this period the temperature and relative humidity of the outside area was recorded. At the end of the ten minutes, the pallets were weighed to establish the amount of moisture present on the pallet structure and were observed to determine the distribution of such moisture.

RESULTS

The weather data of the outside test area was recorded by a hand-aspirated psychometer as follows: Wet bulb temperature, 74°, dry bulb temperature, 82°, relative humidity, 68%. Moisture immediately began to collect on both types of pallets when they were

transferred to the outside platform. This condition was not readily visible to the eye and was determined by running a finger across the pallet structure. The moisture condition resembled a very fine spray.

At the end of ten minutes, beads of sweat formed on the top deck of the Fibreboard Deck Pallet. These beads were of various sizes up to approx. 1/8" and were of a small quantity.

The Rolled Expanded Metal Deck Pallet did not collect beads of sweat on its top surface.

The difference in weights between the dry and wet pallet of both types was negligible.

Both pallets were in a complete state of dryness 20 minutes after outside exposure. At this time the Fibreboard Deck Pallet showed a deformation in the center of the deck. This condition resulted in the top deck of the pallet being permanently raised from the supporting wires a height of approx. 1" at the center whereas previous to this test the top was parallel to the supporting wires.

CONCLUSIONS

Temperature changes will cause both types of steel wire pallets to sweat under favorable conditions. The construction of the Wire Pallet, Rolled Expanded Metal Deck is such that any small amount of water which might deposit upon the top surface would not tend to collect into sizable drops and would evaporate before damage to contents would result. Such is also true of the underneath structure of both pallets. The construction of the deck of the Steel Wire Pallet (Fibreboard Deck) is such as to retain and collect moisture on the top of the pallet in the form of drops. However, such moisture condensing from the pallet alone would not be appreciable under normal sweat conditions.

It is believed that little or no damage would result to pallet loads by sweating of these pallets.

TEST #17 - PERCENTAGE OF TOP AREA

STANDARD TEST PROCEDURE

Each pallet will be measured and the percentage indicated of resisting area on the top of a pallet compared to the total area enclosed between the top dimensions of the pallet.

Shifting of a load upon a pallet is resisted by the area of the pallet in contact with the load. The above test will provide an indication of the resistance to such shifting. The percentage of top area will also give a measure to the ease of loading of a pallet. In loading it is sometimes advantageous to be able to walk on the pallet top area and if an open type pallet is used this may cause some inconvenience to the loaders. Top area percentage will also give an indication of the suitability of such pallets for gluing operations since it is necessary in some cases to glue the load directly to the pallet. If such use is made, a high percentage of top area would be required in order to permit efficient gluing operations under standard procedures. Coefficient of friction index should be listed for each type material used.

TEST CONDITIONS

The actual top area, of the pallets, which would be in contact with a normal load, was measured. This area was compared to the total top area, enclosed by the maximum top dimensions of the pallet in order to obtain a percentage figure.

Suitability for gluing operations was determined by the actual gluing of a load to the top decks of the pallets.

The coefficient of friction for the top of the pallet was determined with a wood box and a paperboard carton by dragging such containers across the top of the pallet by means of a spring balance. The spring balance reading indicating the efforts required to drag the containers across the deck were then compared to the weights of the

respective containers and the coefficient of friction was established as being the ratio of spring balance readings to the weights of the containers. Readings were obtained for both static and sliding friction. For comparative purposes, the Navy Standard Wood Pallet was subjected to the same procedure and static and sliding coefficients of friction also obtained for the wood pallet.

RESULTS

The Steel Wire Pallet (Rolled Expanded Metal Deck) has a top surface percentage of 36%. The deck of the pallet provided ample rigidity and area support when walked upon by warehouse laborers.

The Steel Wire Pallet (Fibreboard Deck) has a top surface percentage of 100% since the deck is a fully enclosed sheet of fibreboard. The deck would not satisfactorily support the weight of warehouse laborers engaged in loading procedures.

The Standard Navy Wood Pallet, has a top surface percentage of 84% and adequately supports the weight of warehouse laborers. This pallet also has sufficient rigidity.

When tests for glued loads were conducted, it was found necessary to apply glue by brush to the decks of the pallets. The deck of the Steel Wire Pallet (Rolled Expanded Metal Deck) was found to permit considerable glue to drop through the diamond shaped openings in the top of the pallet. It was necessary to brush excessive glue over the deck in order to be sure an adequate amount remained for proper adherence. This procedure involved much glue spillage and waste. When boxes of a load were placed upon the deck they were found to be reasonably secure after the drying period. Photo #107-2, Page 112 indicates pattern of glue bond upon containers after disassembly of the glued load. It was found that when the boxes were pulled loose from

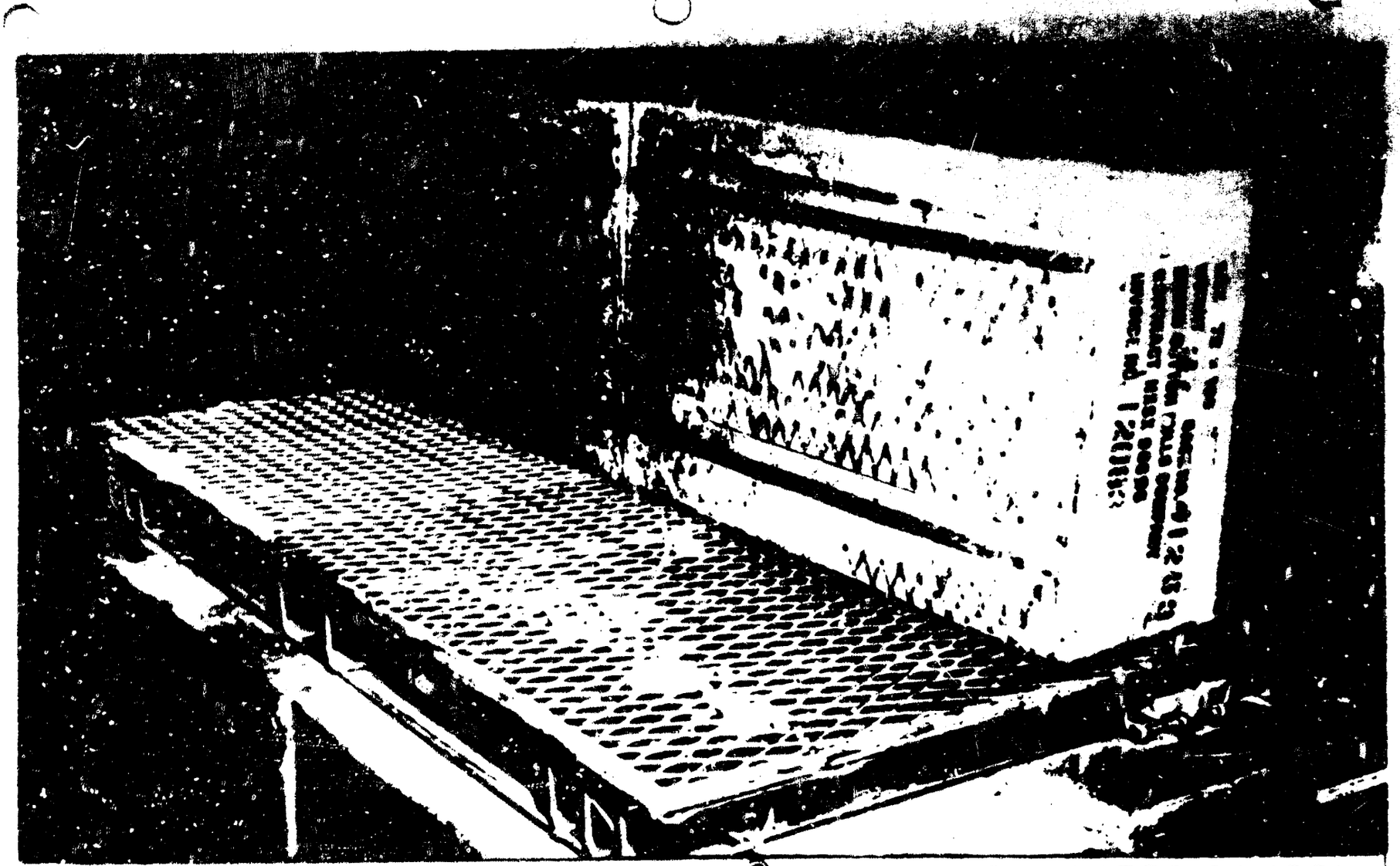


ILLUSTRATION OF EXPANDED METAL DECK CONDITION FOLLOWING DISASSEMBLY OF GLUED LOAD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 107-2 PAGE 112

the deck, that much of the decks protective coating of aluminum was pulled off at the points of glue bond.

The Steel Wire Pallet (Fibreboard Deck) provided ideal glue loading characteristics with its fully enclosed top deck. It was also found with this pallet, however, that much of the decks protective coating of aluminum was pulled off the deck at the points of glue bond.

The coefficients of friction for the three types of pallets were determined in accordance with the following data:

Type of Pallet	Type & Wgt of Container	Nr. of Test Readings	Av. force to start (lbs)	Av. force to keep in motion(lbs)	Coefficient of Friction Static	Sliding
Steel Wire Pallet (Rolled Expanded Metal Deck)	Wood 36#	15	20.0	15.3	.55	.42
	Carton 36½#	12	26.6	23.1	.73	.65
Steel Wire Pallet (Fibreboard Deck)	Wood 36#	10	20.7	16.5	.57	.46
	Carton 36½#	10	21.6	21.9	.59	.59
Standard Navy Wood Pallet (Used)	Wood 33#	12	14.5	12.9	.44	.39
	Carton 40#	12	21.0	13.5	.52	.34

CONCLUSIONS

The Steel Wire Pallet (Rolled Expanded Metal Deck) has a low percentage of top surface but is strong and satisfactory except for the fact that excessive glue is required for the deck when used in glue loading.

The Steel Wire Pallet (Fibreboard Deck) is satisfactory for glue loading but is not practical for normal combat usage due to brittleness of the deck surface.

Both types of pallets show more surface resistance on the top deck than does the Standard Navy Wood Pallet. The coefficients of friction have been obtained with both wood boxes and paperboard cartons which are used in the packaging of most material carried in pallet loads.

TEST #18 - SUITABILITY FOR STEEL STRAPPING OPERATIONS

STANDARD TEST PROCEDURE

Each pallet will be investigated for suitability for steel strapping operations and a report made concerning ease of accomplishing same. Observations will be made relative to slackening tendencies of strapping on each type of pallet.

Although comparatively more expensive than gluing in the ordinary formation of unit loads, it is sometimes necessary to use steel strapping and suitable provisions for strapping should be incorporated in a pallet where this is necessary. This test will indicate suitability of each pallet for strapping purposes.

TEST CONDITIONS

Both types of Steel Wire Pallets were steel strapped with loads of 3,500 lbs by experienced warehouse strapping operators. Observations were made concerning ease of strapping operations and subsequent ability of the pallet to maintain original tightness of the straps and of the contained load. The strapping operators were questioned concerning strapping conditions of the pallets as compared to a Navy Standard Wood Pallet.

RESULTS

Both types of pallets were steel wire strapped in approximately the same amount of time as is used for a Navy Standard Wood Pallet. Strapping operators noted that Steel Wire Pallets were easier to strap due to greater visibility underneath the pallet. The steel wire construction of the pallet permits the pallet to deflect slightly and to maintain a desirable tension against the steel strapping as the straps are tightened. This feature provides an automatic take-up

when rough handling would otherwise cause strap slackening.

During Test #6, Shock Loading, Test #7, Towing Test, Unsupported; Test #8, Toboggan Towing Suitability Test, and Test #19, Suitability for Stevedoring Operations, it was observed that steel strapped loads on both types of steel wire pallets were satisfactory and loosening of straps was not observed under ordinary severe handling. Photographs for such tests illustrate strapping conditions.

CONCLUSIONS

Both types of Steel Wire Pallets are satisfactory for Steel Strapping Operations.

TEST #19 - SUITABILITY FOR STEVEDORING OPERATIONS

TEST PROCEDURE

Each pallet will be tested in order to determine its suitability for Stevedoring Operations and a report made upon such suitability. Loading of palletized cargo by single pallets in stevedoring operations at the present time is usually accomplished by the use of single wing or double wing pallets, and bar slings. Due to the damage usually prevalent on the wings of the wing type pallet, other manufacturers endeavor to eliminate such wings by providing hooks, hook holes, or other holding arrangements or by handling the pallets with cargo nets. The method of accomplishing such maneuver shall be commented upon for each pallet with attention being given to the efficiency of the method. In addition, the following tests are to be conducted upon each pallet in order to simulate conditions to which pallet loads are exposed in the shiploading or unloading process due to faulty cargo handling equipment or improper operation by personnel.

These tests shall be conducted with pallets loaded to weigh approximately 3,500 pounds being hoisted aboard with the use of conventional cables or bar slings and for any other type sling or bridle being considered for use in hoisting palletized loads aboard vessels.

a) Load to be hoisted to a height of 25 feet above ground or dock level. Load then to be lowered away at full speed and brought to a full brake stop about 5 feet above dock or ground level. This test should be completed four times with each pallet.

b) Load to be placed on dock approximately thirty-five feet away from side of ship. Ships gear should pick up load and swing

inboard simultaneously causing load to bump ships side. This test should be repeated at least four times with each pallet. Since there would be considerable chance of injuring the ship structure with the above indicated test, adequate precautions should be taken to fully protect such a ship against pallet impact by boarding up along the ship side, or by simulating this test away from the ship, but under conditions which would be identical.

The above tests are considered necessary to better determine the suitability of pallets and slings or bridles used in loading palletized loads aboard vessels.

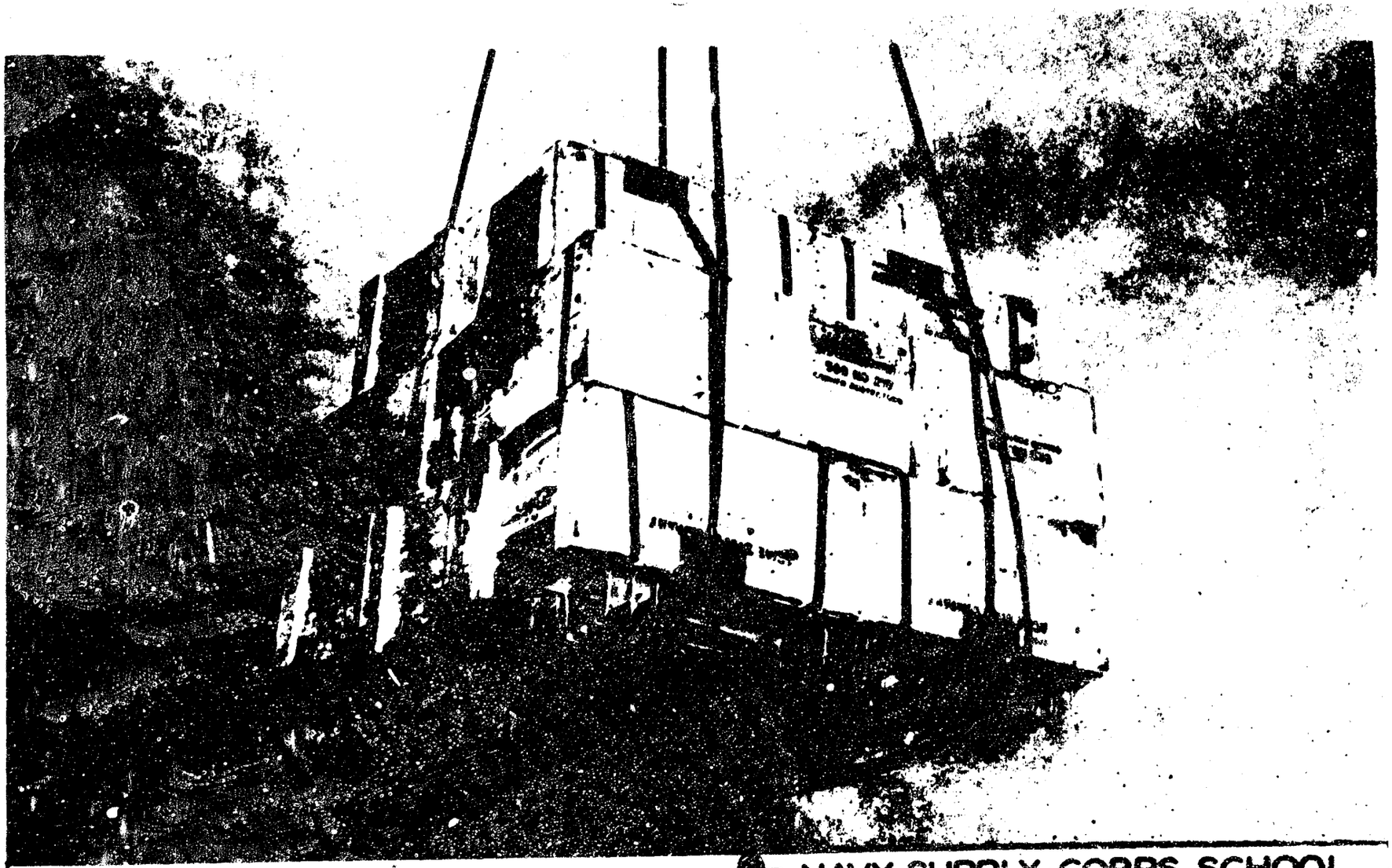
c) Each pallet shall also be investigated for suitability of shiploading by "Ship Conveyor Loading Systems."

Full reports shall be made indicating suitability or unsuitability of subject pallets for stevedoring work in general and specifically for each of the three above indicated tests.

TEST CONDITIONS

Each type of Steel Wire Pallet was loaded with 3,500 lbs of boxed steel edge protectors. This load was steel strapped to the pallet and was then submitted to the following test conditions simulating stevedoring operations. The Standard Navy Wood Pallet was also similarly loaded and submitted to each of the test conditions in order to provide a basis of comparison.

Condition #1 (Drop Test) - One loaded pallet of each type was rigged and suspended by means of a conventional wire cable wrapped under the 3" overhanging wing of the top deck on two sides of the pallet. Such rigging and general condition of the load previous to test is indicated by Photo #42-14, Page 118 . As a preliminary precaution the wire sling was first placed inside the vertical posts of the pallet but this was



CONDITION OF FIBREBOARD DECK PALLET LOADED WITH 3,900 LBS. PRIOR TO DROP TEST WITH SLINGS PLACED UNDER THE PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-14

soon changed to the test position under the wings of the pallet after a trial test indicated load stability and pallet design would permit outside placing of the cable sling as indicated by Photo #42-6, Page 120. The pallet was then hoisted by a mobile crane to a height of approximately 25 feet above the ground. Photo #42-4, Page 121 indicates test conditions at this point. When the loaded pallet reached the required 25 feet from the ground the crane man suddenly relaxed his cables, permitting the pallet to drop freely downward until he braked the drop sharply at a distance about five feet from the ground. This operation was completed four times with each pallet.

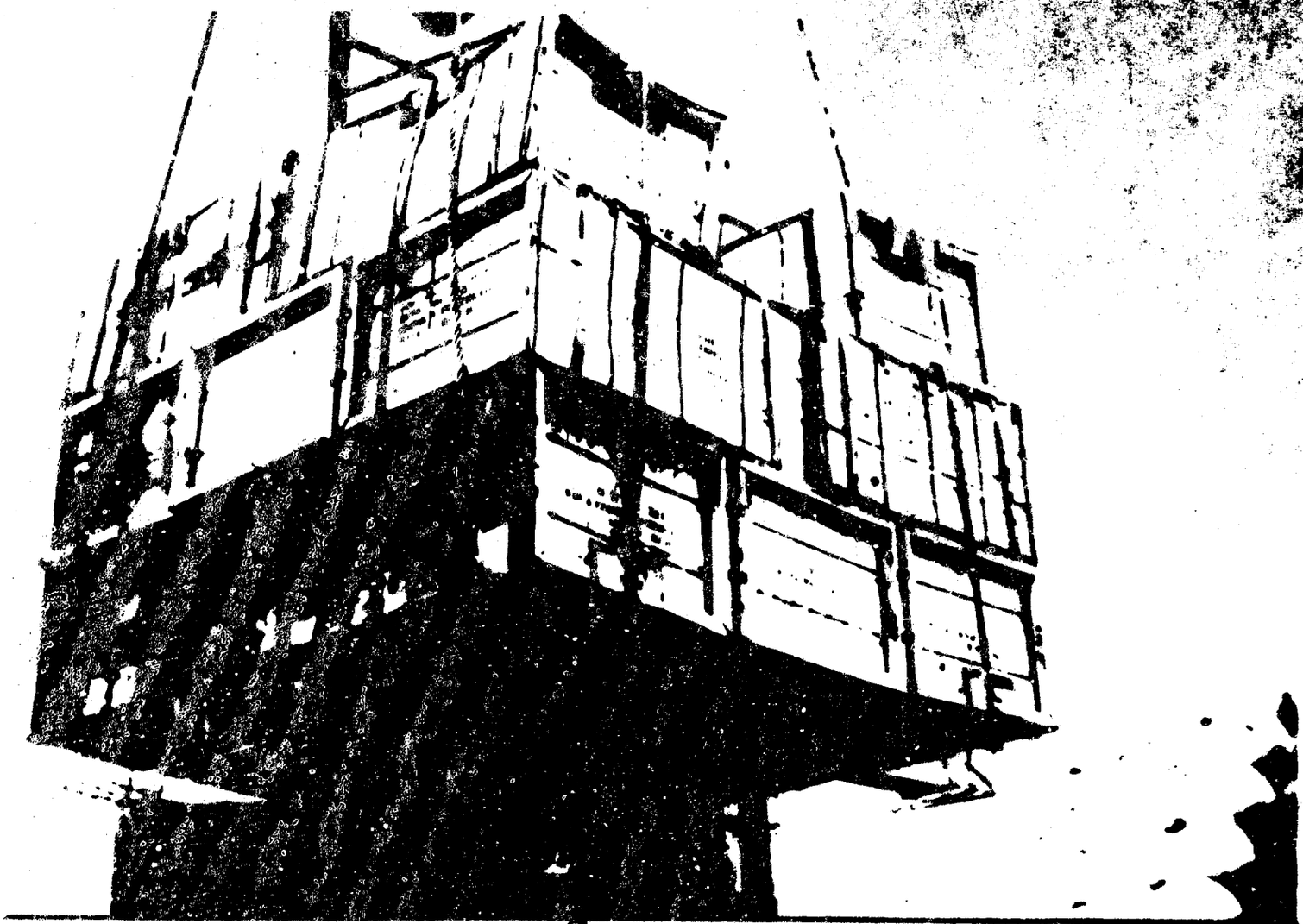
Condition #2 (Impact Test)

One loaded pallet of each type was rigged by means of conventional wire slings under the deck of the pallet. The slings in this test were situated inside the corner vertical wires of the pallet similar to that shown by Photo #42-14, Page 118. A mobile crane standing approximately five feet from an adjacent wall was used to pick up a loaded pallet placed approximately 35 feet from the wall and then to swing the pallet inward to the wall at the same time that the pallet was being hoisted. This operation permitted the loaded pallet to forcibly strike the wall as shown by Photo #42-9, Page 122. This test was completed 4 times with each pallet. It is to be noted that in each type test an elementary type of rigging was used in order to best illustrate worst hoisting conditions where more suitable equipment might not be available as a result of emergency combat action.

RESULTS

Condition #1 (Drop Test)

The Steel Wire Pallet (Rolled Expanded Metal Deck) did not



CONDITION OF EXPANDED METAL DECK PALLET LOADED WITH 3,500 LBS. PRIOR TO DROP TEST WITH SLINGS PLACED UNDER THE WINGS OF THE PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-6

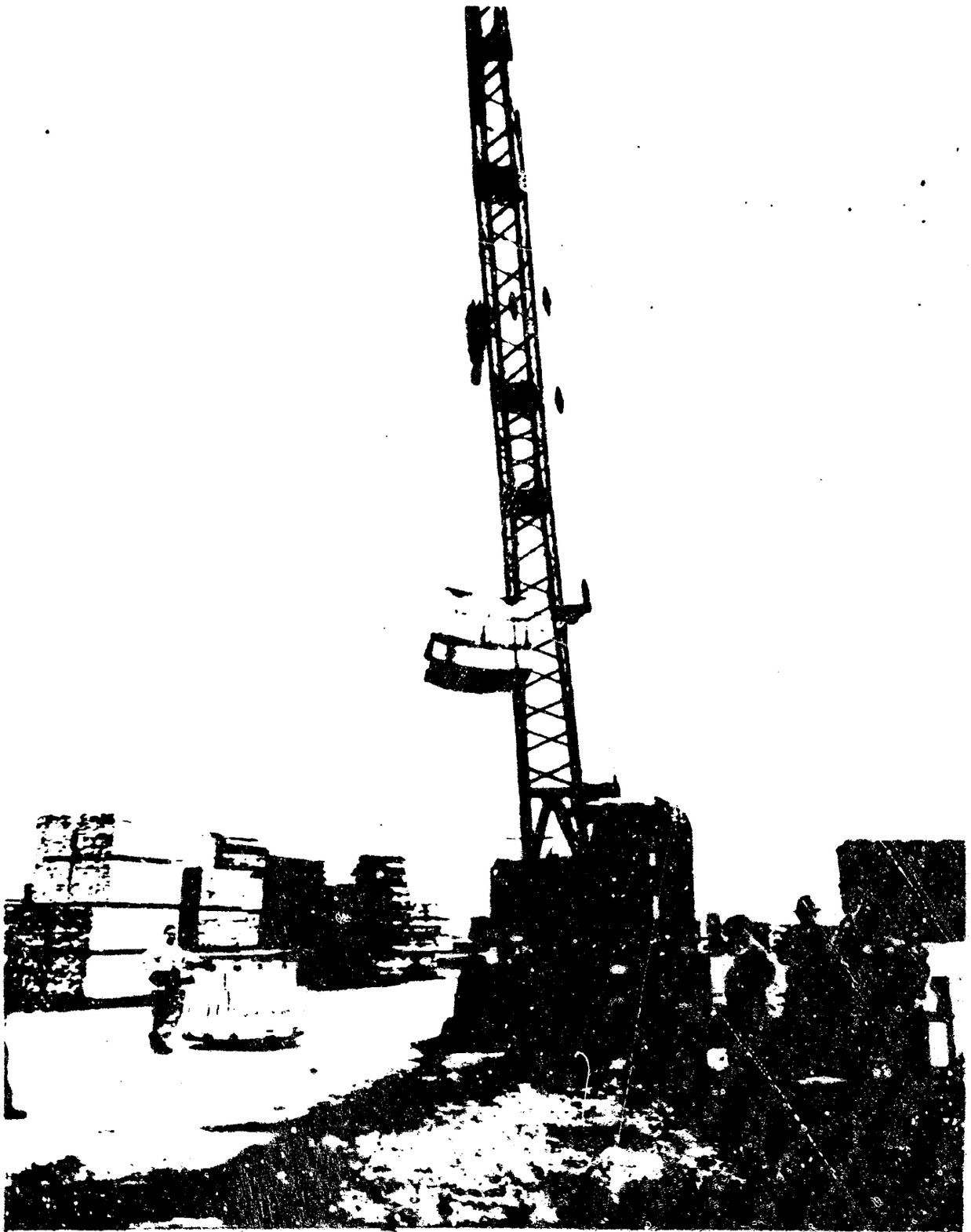
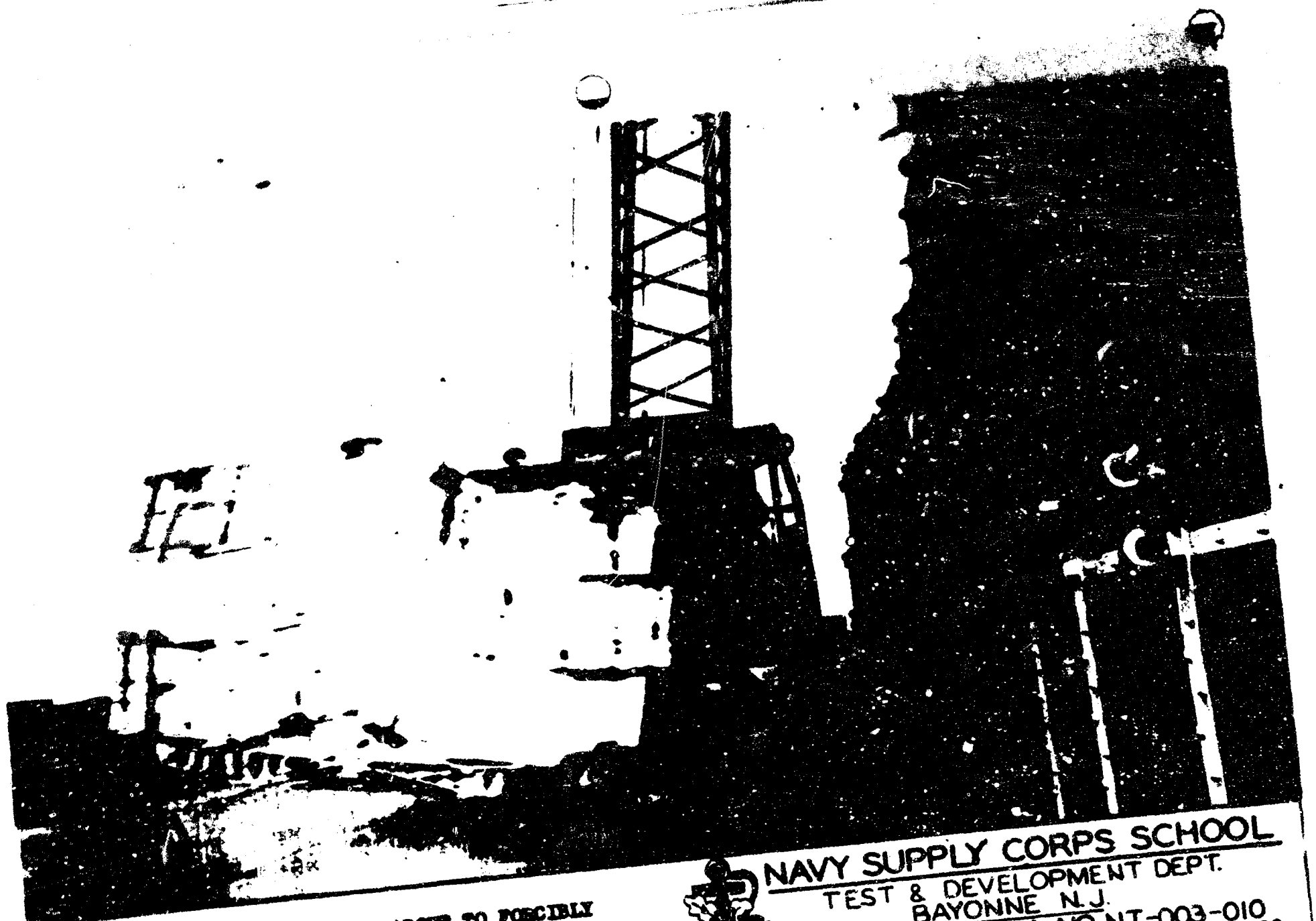


ILLUSTRATION OF CONDITIONS IN DROP TEST FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE NJ
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 4-4 PAGE



EXPANDED METAL DECK PALLET ABOUT TO FORCIBLY STRIKE WALL IN IMPACT TEST OF STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-9

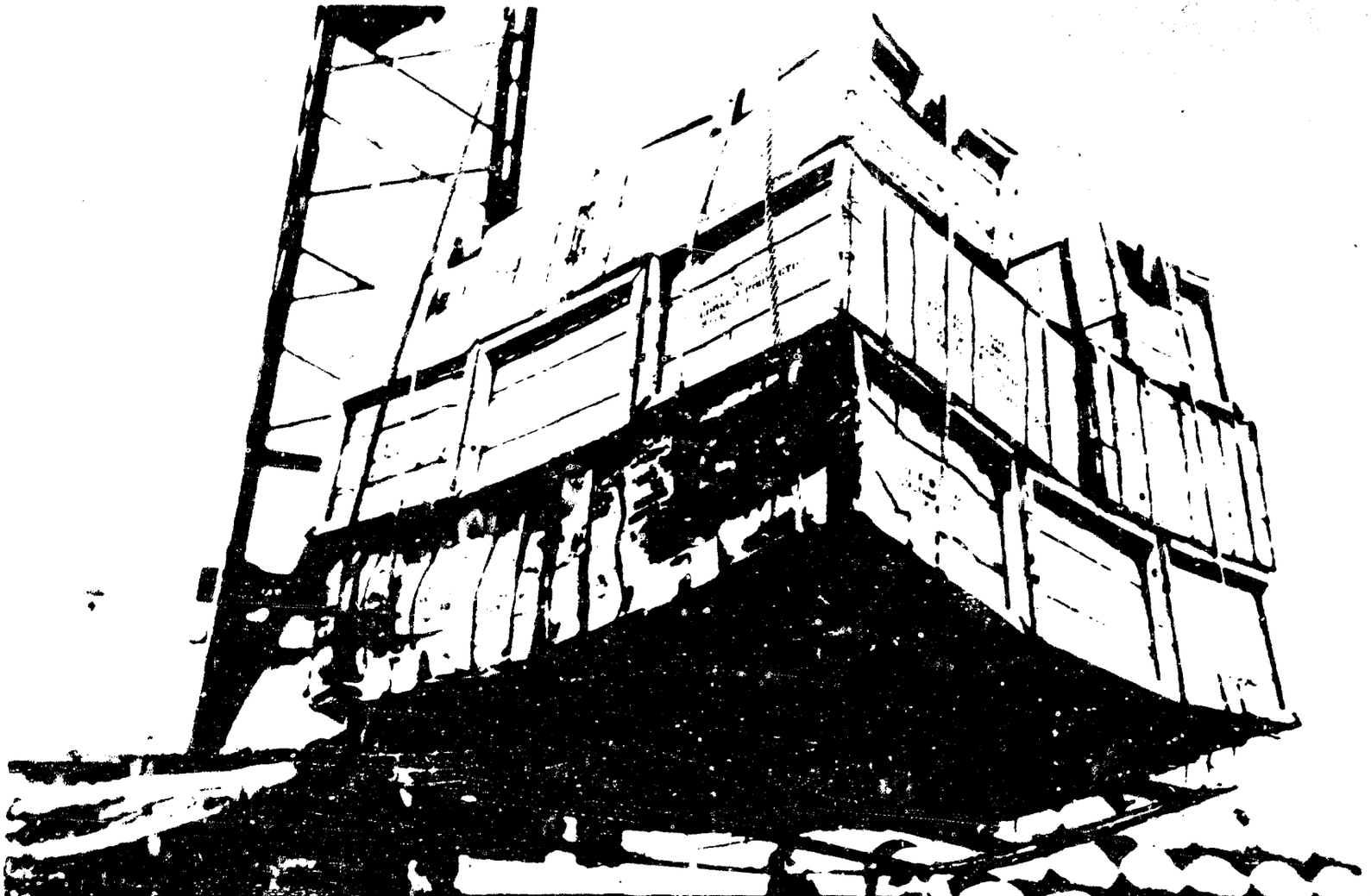
show appreciable damage as a result of the drop tests. As indicated in Photo #42-10, Page 124 , the pallet deck tended to "bow-in" toward the center of the pallet. Damage to containers was slight, steel strapping loosened slightly, but no other physical damage to the pallet or load was noticed. When placed upon the ground this pallet did not quite return to its original shape but the pallet was able to continue to serve its functions and was very easily lifted and carried by fork truck.

The Steel Wire Pallet (Fibreboard Deck) showed a damaging condition existing at the corners of the pallet where the cable slings were located. The center of the deck between the slings bellied slightly This condition grew worse with each drop until after the fourth drop the shape of the pallet had a distinct concave appearance. The wire slings had pulled up the corners of the pallet to such an extent that the first layer of the boxed load was damaged. Photo #42-15, Page 125 indicates this condition and also shows loosening of wire strapping which occurred. When placed on the ground, this pallet did not return to its original position, but was still capable of being lifted by fork truck.

At the completion of the Drop Tests with the Standard Navy Wood Pallet, the end boards of the deck were found pulled away from the vertical stringers. See Photo 51-23, Page 126 and note that in all cases the drive screw nails were pulled out with the boards and that the loosened boards were pulled in an angular direction governed by lifting cables. Such damage would not occur if lifting bars were used.

Condition #2 (Impact Test)

The Steel Wire Pallet (Rolled Expanded Metal Deck) withstood



RESULTS AFTER DROP TESTS FOR STEVEDORING SUITABILITY WITH EXPANDED METAL DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-10 PAGE 124

RESULTS AFTER DROP TESTS FOR STEVEDORING SUITABILITY WITH FIBREBOARD DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE, N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-15 PAGE 126

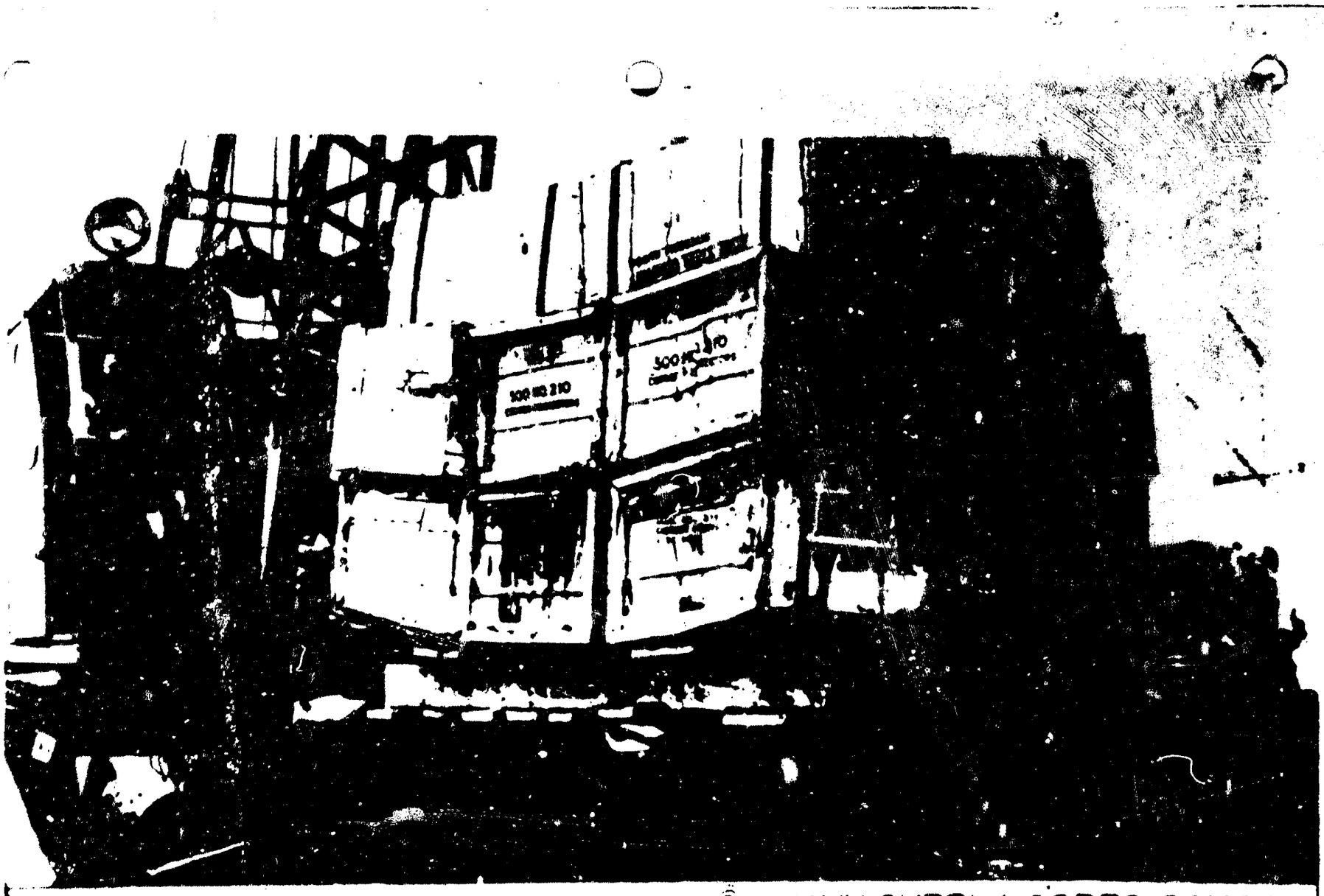


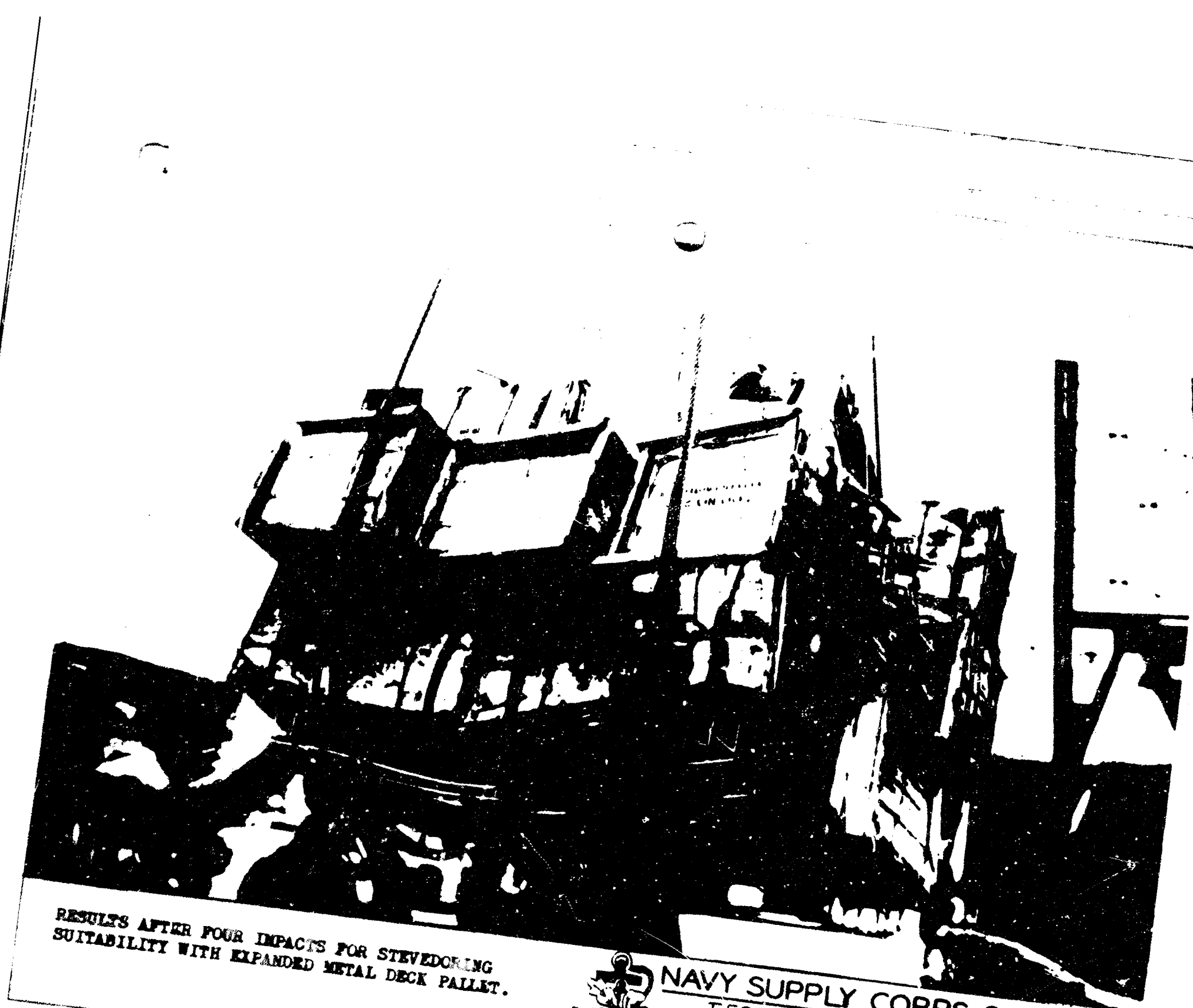
ILLUSTRATION OF RESULTS TO STANDARD NAVY WOOD PALLET FOLLOWING DROP TEST FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT 003-010
PHOTO NEG NO 51-23
PAGE 126

this severe test remarkably well. After the fourth impact against the wall the pallet was only slightly deformed and was still able to hold and protect its load. Condition of the pallet and load is indicated by Photo 42-13, Page 128 .

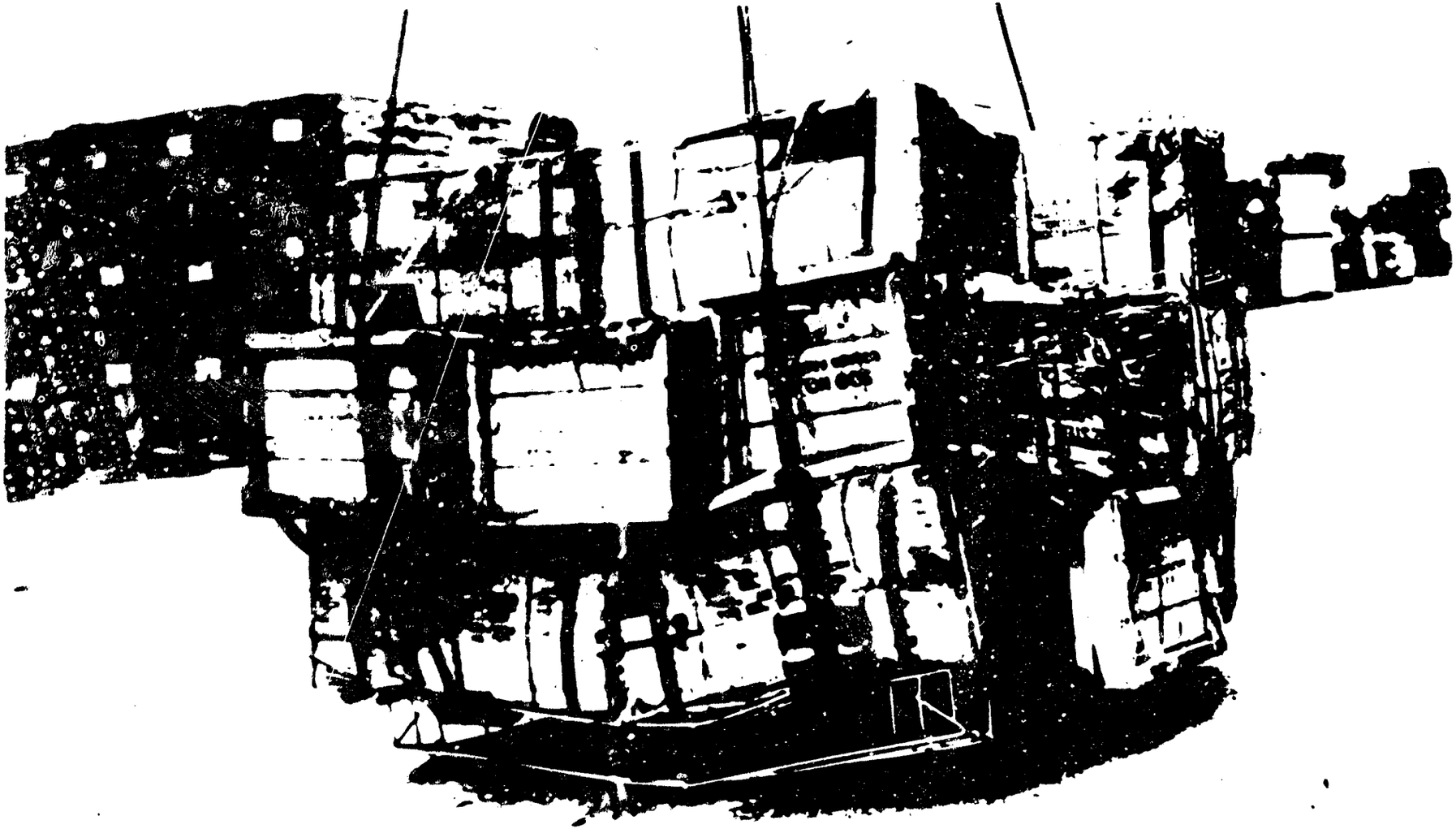
Upon placing the pallet on the ground, it was found that the general efficiency was not greatly impaired and that a fork truck was easily able to lift and move the pallet with its load. Photos 42-8, Page 129 , and 42-16, Page 130 , illustrate conditions existing with the pallet on the ground and loaded on a fork truck after the swing test. The load is noted to be slightly damaged and the steel strapping has loosened to some small degree but the general condition of the load is satisfactory if the severity of the test is given consideration.

The Steel Wire Pallet (Fibreboard Deck) did not successfully withstand the forces of the impact test. At the end of the first and second impact the pallet showed considerable damage and at the end of the third impact the pallet was no longer able to protect the load. The general appearance of the pallet at this time indicated that it could no longer perform its required functions. The pallet corners upon which impact had been received, had been damaged so that the load was receiving the full force of impact which resulted in severe damage to the load. The pallet deck had broken up throughout its entire surface. The general result at the conclusion of the impact test is indicated by Photo 42-17, Page 131 . When the pallet was placed upon the ground it straightened out slightly, as Photo 42-18, Page 132 , and a fork truck was able to pick up the pallet and its load. As may be observed in such photo the load was in a distorted state and the boxed load was damaged to such an extent that part of the load was crushed and had fallen from the pallet. The shape of



RESULTS AFTER FOUR IMPACTS FOR STEVEDORING
SUITABILITY WITH EXPANDED METAL DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 42-13

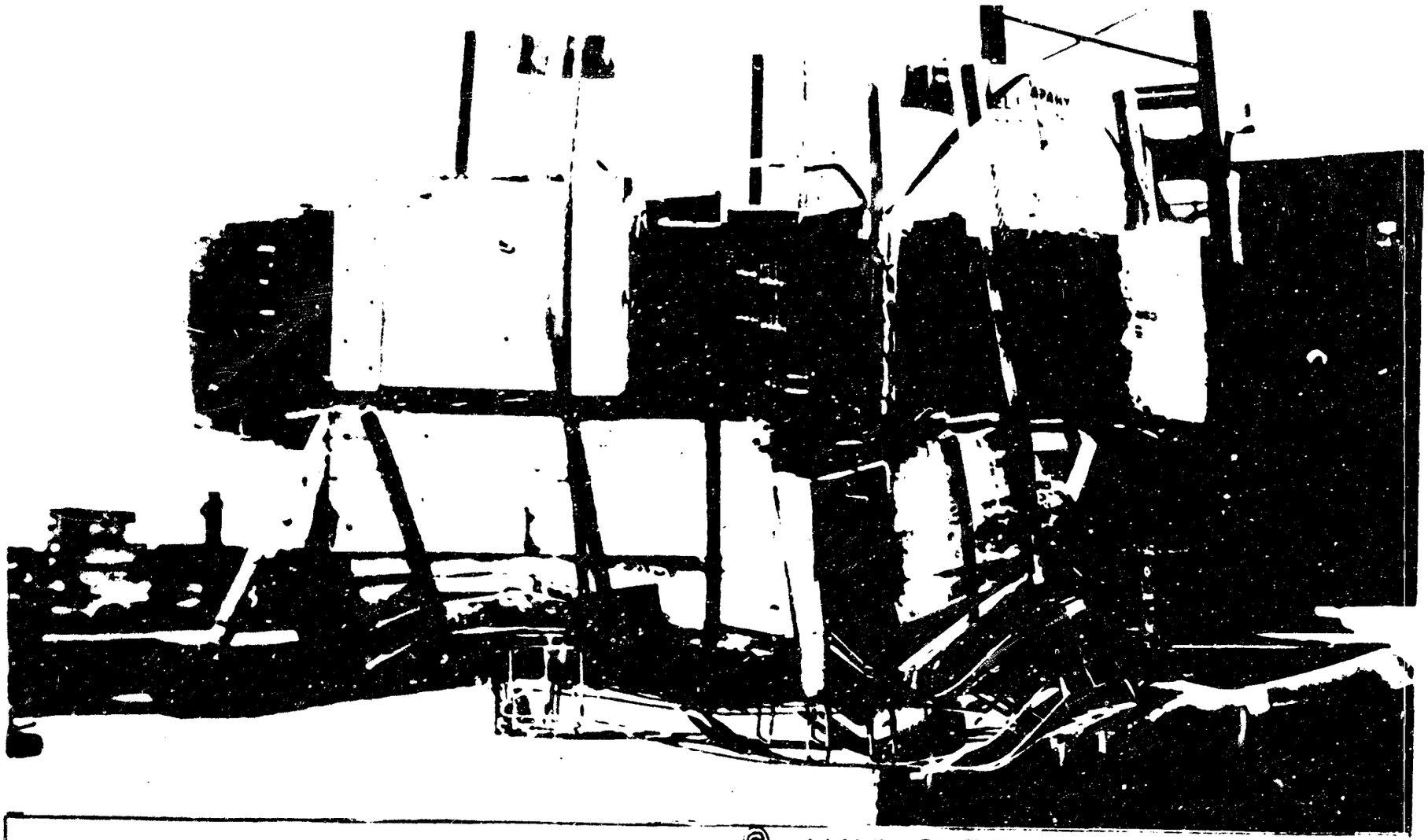


EXPANDED METAL DECK PALLET LOWERED TO GROUND FOLLOWING IMPACT TESTS FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-8 PAGE 129

ILLUSTRATION OF FORK TRUCK PICK-UP OF EXPANDED METAL DECK PALLET FOLLOWING IMPACT TESTS FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 42-16 PAGE 130



RESULTS AFTER THREE IMPACTS DURING STEVEDORING TEST WITH FIBREBOARD DECK PALLET.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 42-17

FIBREBOARD DECK PALLET LOWERED TO GROUND AFTER IMPACT STEVEDORING TESTS. NOTE DISTORTED STATE OF LOAD.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 42-18 PAGE 132

the pallet had distorted from a square to an oblique figure. Photo #42-11, Page 134 indicates appearance of the pallet after it had straightened out when placed upon the ground and after lifting by fork truck. No difficulty was experienced in making such lift.

The Standard Navy Wood Pallet was able to successfully withstand the impact test with little damage to the pallet and to the load. Photo #67-72, Page 135 indicates condition after three impacts. It is noted that end boards were pulled up due to use of simple cable sling and that the boards pulled off over the heads of the drive screw nails. This test caused the pallet to rack with a total distortion of 12 inches. The pallet together with its load was readily picked up by fork truck from the ground upon conclusion of this test as shown by Photo 67-73, Page 136.

Condition #3 - Suitability for Ship Conveyor Loading Systems -

Both the Steel Wire Pallets and the Standard Navy Wood Pallet are judged satisfactory for Ship Conveyor Loading Systems

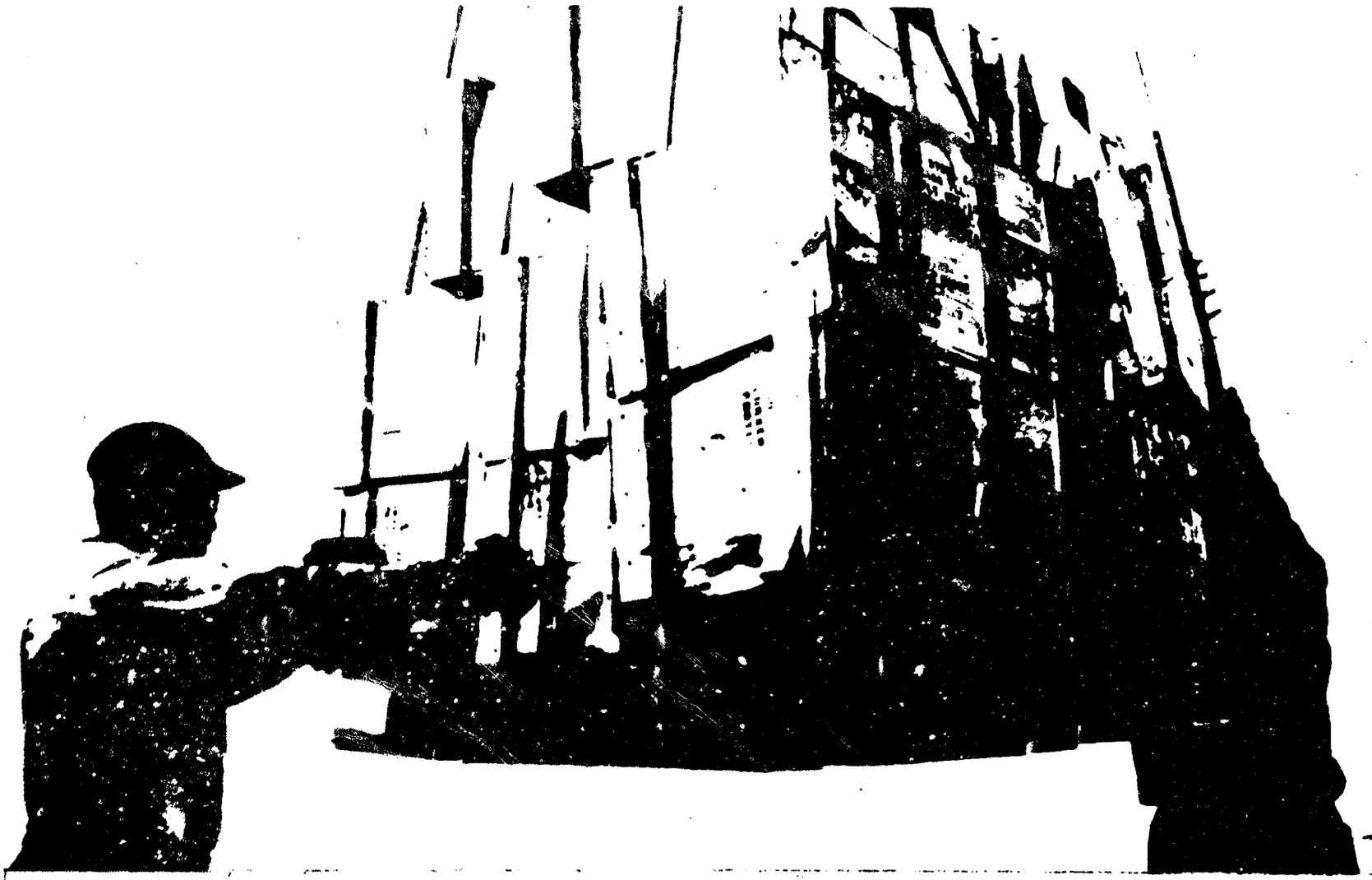
CONCLUSIONS

The Steel Wire Pallet (Rolled Expanded Metal Deck) is suitable and satisfactory for Stevedoring Operations. With this type pallet, the metal deck strongly reinforces the underneath structure of the pallet with the result of a structure which is light in weight, but which possesses remarkable resiliency and affords considerable protection to its load. It is possible for such pallet to absorb punishment without seriously affecting its primary functions and can be expected to successfully withstand stevedoring abuse.

The Steel Wire Pallet (Fibreboard Deck) is not suitable and is not satisfactory for stevedoring operations. The deck of this pallet is brittle and weak and offers no reinforcement to the understructure

ILLUSTRATION OF FORK TRUCK PICK-UP OF FIBRE-BOARD DECK PALLET FOLLOWING IMPACT TESTS FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 42-11



DAMAGES TO STANDARD NAVY WOOD PALLET FOLLOWING IMPACT TEST FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVEL PMENT DEPT
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-72 PAGE 135

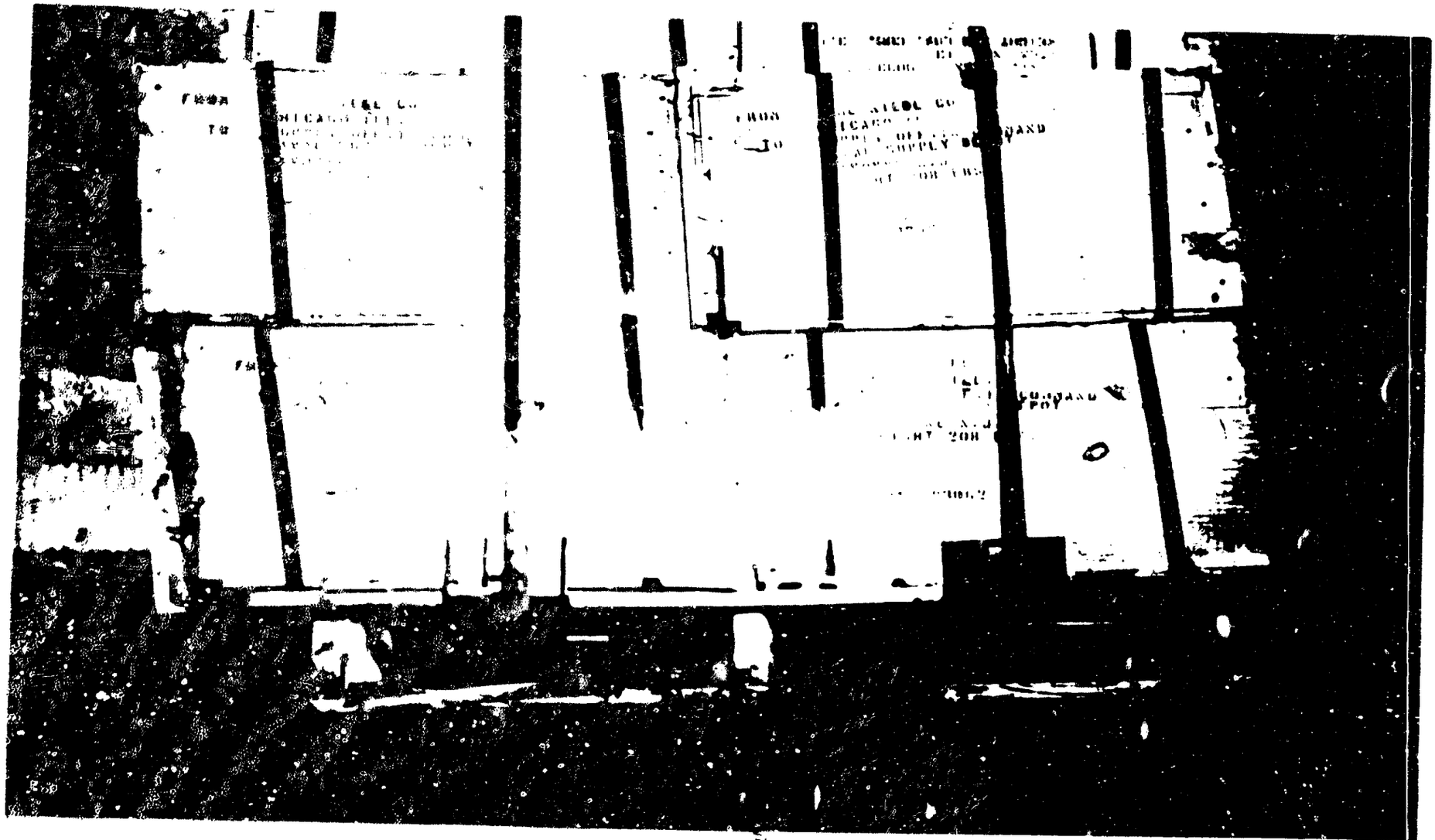


ILLUSTRATION OF FORK TRUCK PICK-UP OF STANDARD NAVY WOOD PALLET FOLLOWING IMPACT TEST FOR STEVEDORING SUITABILITY.

NAVY SUPPLY CORPS SCHOOL

PROJECT SERIAL NO. NT-123-010

PHOTO NEG NO. 67-73

of the pallet. Upon impact the deck cracks, the pallet distorts, and no protection is offered to the pallet load. If punishment of the pallet is continued, the pallet soon deforms so as to become practically useless and the load disintegrates.

The Standard Navy Wood Pallet is satisfactory for stevedoring operations.

TEST #20 - ENTRANCE POSSIBILITIES

[redacted]

Each pallet will be investigated to determine the number of possible entrances to the pallet by means of a fork truck.

Pallets are normally classed as two way, four way, or eight way pallets depending upon whether or not the pallets may be entered from the sides or ends, from both sides and ends, and from the ends, sides and corners. The effectiveness of the eight way pallet has possibly been overamphasized. In general loading use, such as might be encountered on an automobile trailer truck of flat bed type where the trailer may be loaded from the sides, and then unloaded from the end while backed up to an unloading dock, a four-way entrance pallet would normally meet all requirements. A large number of operations are encountered where only a two-way pallet is necessary and there are possible exceptional usages in which the eight-way pallet is desirable. Where eight-way pallets are specified and are not actually required for loading conditions, a user may find he is paying a premium price for an impractical advantage. This test is designed to furnish entrance information for each pallet and the type selected for a given use may be established by a knowledge of the requirements. Navy preference, in most instances, is for a four-way pallet, particularly for truck and plane loading.

TEST CONDITIONS

Each of the two types of Steel Wire Pallets were assembled with loads of 2200 lbs. Actual demonstrations were then made by having fork trucks utilize all possible approach positions of the forks to the pallets. Such pallets were picked up under each possible entrance condition, carried a distance of 25 ft., and tiered on top of

a three high stack of pallets. The pallets were then returned to their original location by reversing this procedure.

RESULTS

The Steel Wire Pallet (Rolled Expended Metal Deck) and the Steel Wire Pallet (Fibreboard Deck) were each possible of successful lifting by a fork truck from eight different approach positions, thereby fulfilling requirements for an 8 way pallet. It was found, however, that in order to make pickups from the corners of the pallet, it was necessary to shorten the normal operating spacing of the forks on the fork trucks in order that the forks might enter sufficiently far into the pallet without encountering obstructions.

CONCLUSIONS

Both types of Steel Wire Pallets successfully meet Navy requirements for four way pallets and in addition may be moved in emergencies from the corners of the pallet as well as from the sides. The design of these pallets is superior in this respect to the Navy Standard Wood Pallet which is merely a two way pallet.

TEST #21 - CLEARANCE ALLOWANCE FOR LIFT TRUCKS

STANDARD TEST PROCEDURE

Each pallet shall be measured to indicate the vertical clearance allowance for the insertion of forks on lift trucks and hand pallet trucks.

A minimum of 3 5/8" is normally required for the above indicated purpose. Any amount below this figure would probably require excessive operator time for fork insertion and would cause damage to stringers or posts. A dimension appreciably larger than 3-5/8" would ordinarily just represent so much lost space as the addition would not be required.

TEST CONDITIONS

Both types of Steel Wire Pallets were examined carefully in order to ascertain if design conditions existed which might hamper fork truck operations. Measurements were taken on these pallets in respect to the actual space allowed for fork insertion of the fork lift trucks. Pallets were then submitted to Fork Truck operation and observations made in regard to practical clearances during normal working conditions.

RESULTS

The minimum height of space for fork insertion in each type pallet is 3-3/8". On two sides of the pallet this space increases to 4". During actual fork truck operations with loaded pallets it was found that the forks contacted and bent one of the .264" dia. deck support horizontal wires when the forks were inserted under the pallet at a slightly backward angle. Fork truck operators do not normally enter the forks of their truck into a pallet with the forks inclined

but occasionally this is done to save time when operations are speeded. Such practice subjects this type of pallet to damage.

It was also found that under certain types of concentrated loads the deck of the Steel Wire Pallet (Fibreboard Deck) would deflect downward and that such deflection would decrease the allowable height for insertion of forks on fork trucks.

CONCLUSIONS

The designs of both types of pallets are satisfactory in regard to proper allowance for insertion of forks on fork lift trucks. Although slightly below the suggested minimum spacing of 3 5/8" the difference in this case will not seriously affect operations.

TEST #22 - PICK UP TEST

STANDARD TEST PROCEDURE

Each pallet shall be lifted by both lift fork truck and hand lift truck and suitability for each type of lifting shall be reported upon. Special attention shall be given to the portions of the pallet transferring the load to the forks to determine proper design for strength and the non-necessity for exact locations of the forks in order to obtain proper load distribution. Attention shall also be given to the space allowed in the underside of the pallet for hand lift truck wheels. Practical usage demands that this dimension be approximately 11½" wide to allow for spacing of the wheels when overhang may exist on the front of the pallet prohibiting exact spacing of the rear wheels. A space of 6½" is usually sufficient if no overhang will occur, but the difference is required for tolerance as has been shown by experience and damage of botton structure will result if such tolerance is not provided.

This test will provide information of use in the occasions wherein it is necessary to use pallets on both fork lift trucks and hand lift trucks.

TEST CONDITIONS

A load of 3,500 lb was placed on a pallet of each of the Steel Wire design and such pallets were lifted from the ground by both lift truck and by hand truck. The equipment used was as follows:

1 - One "Clark" 4000# capacity standard Carloader Fork Truck.

2 - One "Yale & Towne" Hydraulic Hand Pallet Truck, Model Number H-4FP1031/48, Serial No. 454256, Capacity 4,000 lbs.

3 - One Electric Automatic Transporter manufactured by the Automatic Transportation Co., Capacity 4,000 lbs. Serial #4150, Model No. P-42748.

During this procedure the equipment was entered under the pallet for lifting from all entrance possibilities of the forks as determined by Test #20. Actual measurements were taken of the space allowed in the underside of the pallets for hand lift truck wheels and observations were made during the pick up test for proper pallet load distribution on the lift trucks.

TEST RESULTS

Both types of pallets were lifted by a fork truck from 8 different directions, including the ends, sides and corners. When the pallets were lifted from the corners, the normal spacing of the forks had to be shortened in order to fit the space provided. This decrease in width of fork spacing resulted in an unstable pallet load which required extreme caution during fork truck movement.

Both types of pallets have similar space allowance for pallet hand truck wheels. This dimension measures 16" with the 3" wide ribbed formed plates parallel to the forks and 12" when these plates are placed 90° to the forks.

The pallets were effectively lifted by the pallet hand trucks with the 3" wide ribbed bottom plates placed 90° to the forks. When the forks were placed parallel to the ribbed plates, interference developed, on the lift, between the inner brackets of the rear truck wheels and the two middle 3" wide ribbed bottom plates on the pallet. Examination revealed that the distance between the inner brackets was 10⅜" and the overall width created by the two center spaced 3" wide ribbed plates was 12" resulting in a total 1⅝" interference as the wheel brackets come down. When jacking of the lift truck is initiated, the pivoted wheel brackets are forced downward which raises the forks and the contained pallet off of the ground. When the pallet is raised

approximately a half inch off of the ground the pallet bottom plates contact the [illegible] edge of the lift truck wheel brackets and if the jacking action is continued the bottom plates and wires of the pallet are distorted and damaged.

CONCLUSIONS

Both pallets are capable of being lifted by both powered and hand operated materials handling equipment. However, when hand lift pallet equipment is used, effective lifting may only be accomplished at two sides. If an attempt is made by the manufacturer to redesign the bottom of the pallet by bringing the two middle support plates closer together in order to permit hand truck lifting on 4 sides instead of two, the surface bearing support of the bottom side of the pallet will be negatively affected.

TEST #23 - PROVISION FOR REPAIR

STANDARD TEST PROCEDURE

Each pallet shall be inspected to determine what provisions may have been incorporated in the pallet by the manufacturer to provide for repair or replacement of damaged component parts, in case of damage, and a report shall be made of such provisions.

Due to the rough handling received by pallets there is always the possibility of structural damage. Stringers or posts separating the pallet top and bottom are particularly subject to damage by the forks of lift trucks. It is usually advantageous to have pallets constructed so that they may be quickly disassembled and repairs easily made. This test will indicate the degree to which such provisions have been made for each pallet.

TEST CONDITIONS

A complete structural study was made on each type pallet to determine what provisions for repair were incorporated in the pallet design. Damages occurring to these pallets during all tests included in the Navy Standard Test Procedure for Pallets were observed and used as a basis of types of damage most likely to occur during the life expectancy of the pallets. Consideration has been given to production time, nature of equipment and facilities required to repair damage to these pallets.

An attempt was also made to design a simple repair tool which could be used to repair damaged pallets.

RESULTS

Both types of pallets are of a welded construction and therefore damaged portions of the pallet are not readily replaced without welding operators and equipment. From actual experience during tests

of the Standard Test Procedure it was found that the type of damage most likely to result before complete breakdown of the pallet, was the bending of the vertical and bottom bearing support wires. A simple wire straightening tool operating on a lever principle was developed and found practical where bending damage was slight and of a minor nature. Photo #152, Page ___ indicates use of this tool. When bends are severe, this tool cannot be successfully used. When such severe damage is encountered the only practical method of repair which has been found, is the burning off of the damaged member by welding apparatus and the replacement of the injured member by the welding in of a similar piece. It was found with the fibreboard deck type pallet that the fibreboard was very readily fractured during normal operations and was not capable of repair when damaged. In such cases complete replacement of the deck would have to be made which would not be economical.

CONCLUSIONS

Both types of pallets do not permit rapid disassembly when repairs are necessary. To properly replace damaged parts of the pallet, the services of a skilled welder with suitable equipment is required, together with replacement parts. The use of the Steel Wire Pallet (Fibreboard Deck) is not at all practical due to easy fracture of the deck during normal operations.

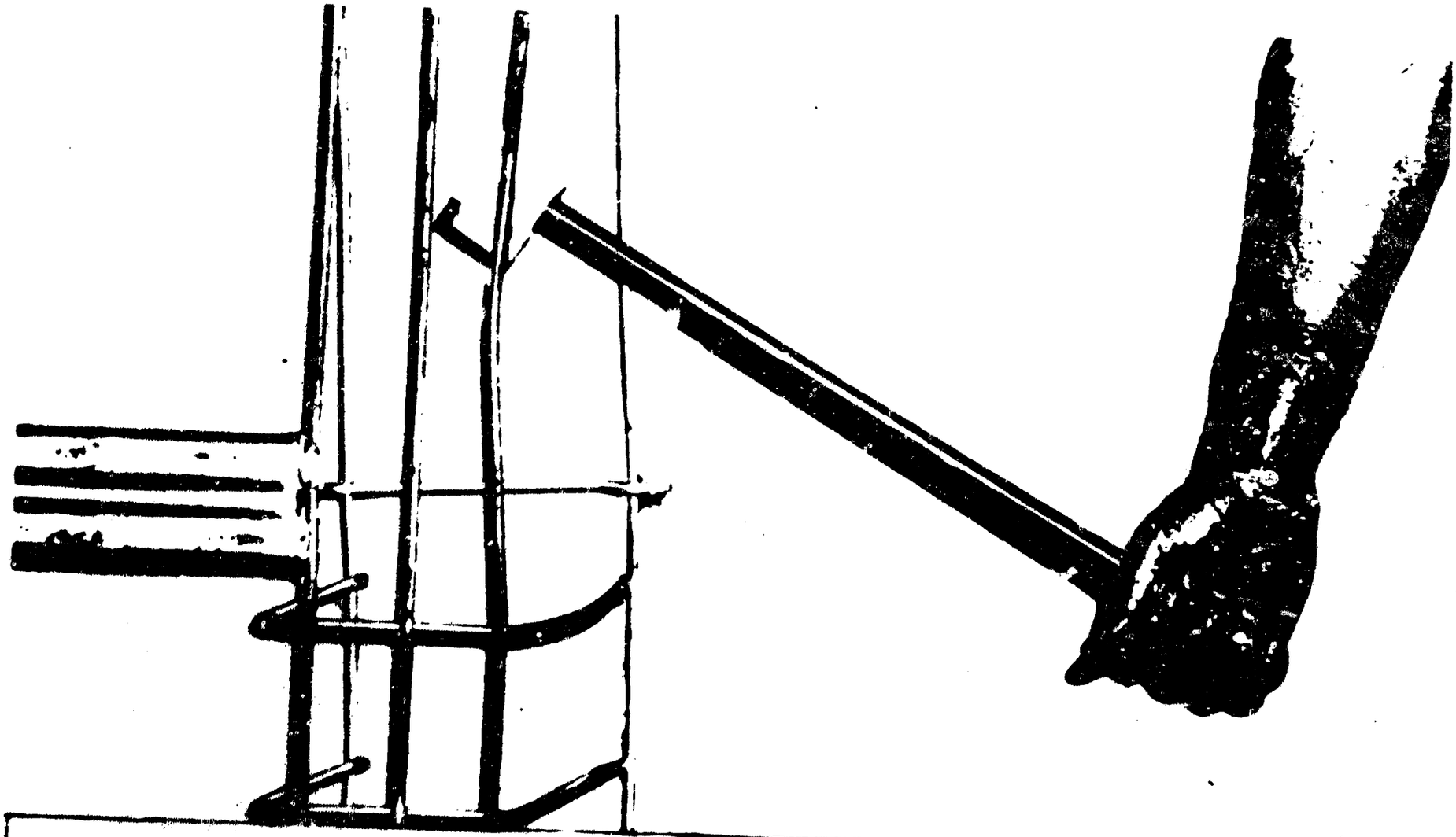


ILLUSTRATION OF WIRE STRAIGHTENING TOOL SET-UP FOR [illegible] WIRE SIZES. TOOL NOT ADAPTABLE FOR [illegible] WIRE SIZES.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 152
PAGE 147

TEST #24 - NESTING AND DUNNAGE CAPACITY

STANDARD TEST PROCEDURE

Each pallet shall be investigated and a report made to determine if special provision has been made to adapt pallets for nesting and for satisfactory use as dunnage.

Pallets are sometimes designed so that they may be nested or interwoven resulting in very little lost space when shipping empty pallets. This results in lower freight rates per unit pallet when empty pallets must be moved. Provision for nesting usually results in good capacity for use as dunnage in that several effective thicknesses of pallet combinations may be obtained. This may be of advantage when pallets are used as dunnage. This investigation is designed to give nesting and dunnage information where such may be important.

TEST CONDITIONS

Both types of Steel Wire Pallets were carefully investigated to note conditions applicable to this test. Ordinarily when pallets indicated nesting characteristics, physical attempts are made with the empty pallets to illustrate this feature. Measurements are also made of different thickness provided by a combination of pallets in order to determine the dunnage capabilities provided by the pallet design.

RESULTS

Both types of pallet designs do not provide for nesting possibilities.

CONCLUSIONS

The design of both types of pallets is not applicable to conditions of this test. However, these pallets are recommended for dunnage purposes when the full height or a combination of full heights of the pallet can be utilized to fill the required space.

TEST #25 - FREIGHT HUMPING SUITABILITY

STANDARD TEST PROCEDURE

Each pallet shall be tested for Freight Humping Suitability by being loaded with a uniform load of approx. 3,500 pounds per pallet and being humped at a speed of 9 to 12 miles per hour in a freight car.

This test is deemed necessary to indicate the suitability of pallets to normal railroad freighting operations. Practical experience and trial shipments have indicated that some pallets have been found weak in shearing resistance when opposing forces have been applied to the top and bottom faces. It is believed the above test will indicate the acceptability of pallets for railroad freight shipments.

TEST CONDITIONS

Three pallets each of the Steel Wire Pallet (Expanded Metal Deck) and Steel Wire Pallet (Fibreboard Deck) were loaded with a uniform load of 3,048 lbs consisting of boxed metal material. The load was steel strapped to each pallet and was placed by fork truck on the floor of the freight cars. When the vertical posts, stringers, or understructure bearing support members indicated possible different directional positioning of these members, these pallets were arranged so that one of each type was placed on the car floor with its directional components at an angle of 90° to another of the same type. As an illustration, one of the two Standard Navy Wood Pallets, used in this test for comparative purposes, was placed with its stringers parallel to the direction of travel of the freight car. The other Standard Navy Wood Pallet was placed with its stringers athwart the freight car, or at a 90° angle to the direction of travel. The purpose of this placement was to subject the pallets to forces applied

in the direction of the directional components of the pallet and at 90° to the direction of the directional components. Results later showed failure in one of these directions but not in the other.

No attempt was made to brace the palletized loads in the freight car as it was desired to perform this test under most severe conditions which could be obtained in practical use. The pallets were therefore spaced along the freight car floor with a minimum space of 6" between all test pallets prior to the humping operations. The freight cars containing the loaded pallets were then subjected to a series of freight humping procedures in which the test car was made to travel freely along the rails at speeds ranging from 5 to 12 miles per hour until they hit stationary bumper cars. The speed of the test cars during humping tests was established by an electrically operated contact timer called an Impactometer. This instrument was manufactured by the Nilsson Electric Laboratories in New York City and was the subject of a previous report by this department, Project Number 2.3030, "Carloading, Impactometer" Report #1, Serial #24 dated 11/10/44.

A minimum of two impacts was accomplished with each end of the freight car placed forward. Inspection of test pallets was made after each humping operation. At the completion of such operations, the pallets were unloaded and inspected carefully for structural failures.

The test freight cars used in this test were old style surplus Army box type wooden freight cars with flooring in a considerably used condition. The car numbers assigned by the Army to these cars are #232882, 232876, 232886.

Of the three pallets of each type used in this test, one of each type was unused and two of each type were pallets which had been used in previous tests of the Standard Test Procedure and were slightly

damaged. Such damage, however, was not more severe than the pallets would ordinarily receive in normal materials handling operations. By such test conditions it was expected to illustrate humping effects on pallets in both new and used conditions.

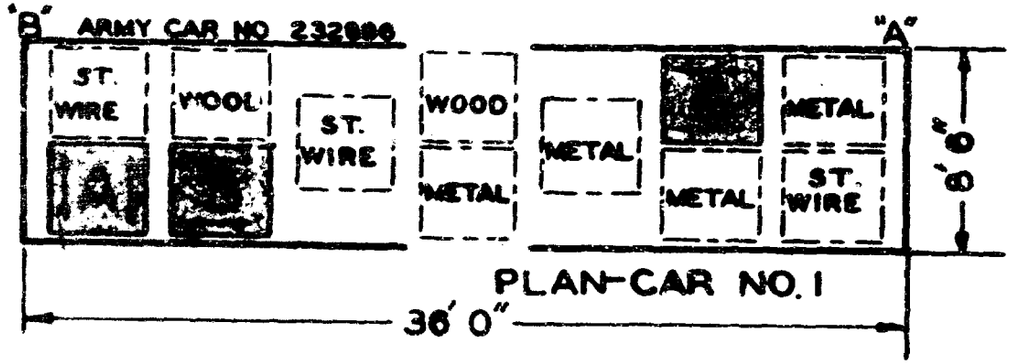
Sketch on Page 152 indicates pallet arrangement in freight cars, identification symbols, and pre-test condition of each pallet used.

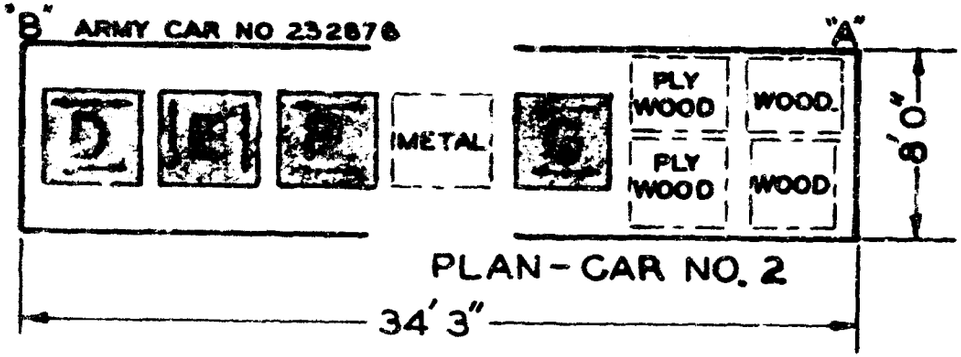
Reference to the sketch will indicate the presence of additional pallets in the test cars. Such pallets were included for testing convenience and will be reported upon in a later project NT-003-004, "Pallets, New Developments." Such pallets are identified at the present time only by their type.

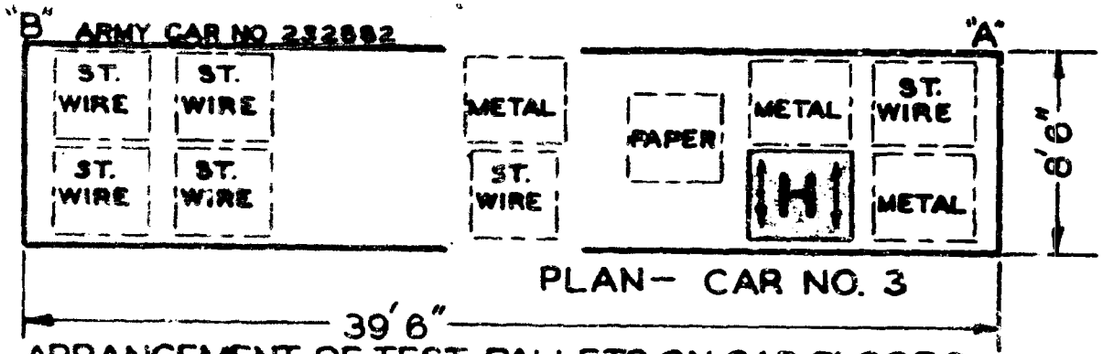
Photographs showing loading conditions inside of freight cars previous to humping are as follows, Car #232886 "B" end Photo 67-48, Page 153; Car #232886 "A" end Photo 67-47, Page 154; Car #232876 "B" end Photo 67-45, Page 155; Car #232876 "A" end, Photo 67-46, Page 156; Car 232882 "B" end Photo 67-44, Page 157.

RESULTS

1st Impact	Observations
All cars humped together due to trainman's error. Speed 5.6 mph "A" end of car #232886 struck.	Total shift of pallets from "B" end toward "A" end in all cars. No pallet damage.
2nd Impact	**Observations**
Car #232886 Speed 6.2 mph "A" end struck.	Further general compression of pallet loads noted. Pallet "A" vertical post wire broke off at weld. Pallet "B", 3" wide ribbed formed plate bent upward affecting







ARRANGEMENT OF TEST PALLETS ON CAR FLOORS

SCALE: 1/8"=1'-0"

NOTE:

1- SHADED OUTLINES ARE PALLETS UNDER TEST IN THIS PROJECT.

2- ARROWS INDICATE DIRECTION OF 3" WIDE BOTTOM PLATES OF THE STEEL WIRE PALLETS OR VERTICAL STRINGERS OF THE STANDARD NAVY WOOD PALLETS.

IDENTIFICATION OF PALLETS UNDER THIS REPORT AND CUMULATIVE DAMAGE TO EACH PALLET

PALLET "A"- STEEL WIRE PALLET(EXPANDED METAL DECK) Condition of pallet was quite good.

PALLET "B"- STEEL WIRE PALLET(FIBREBOARD DECK) Condition of pallet good except for part of deck breakdown due to impact of box landing for test.

PALLET "C"- STANDARD NAVY WOOD PALLET Condition good. Pallet was used in Depot work.

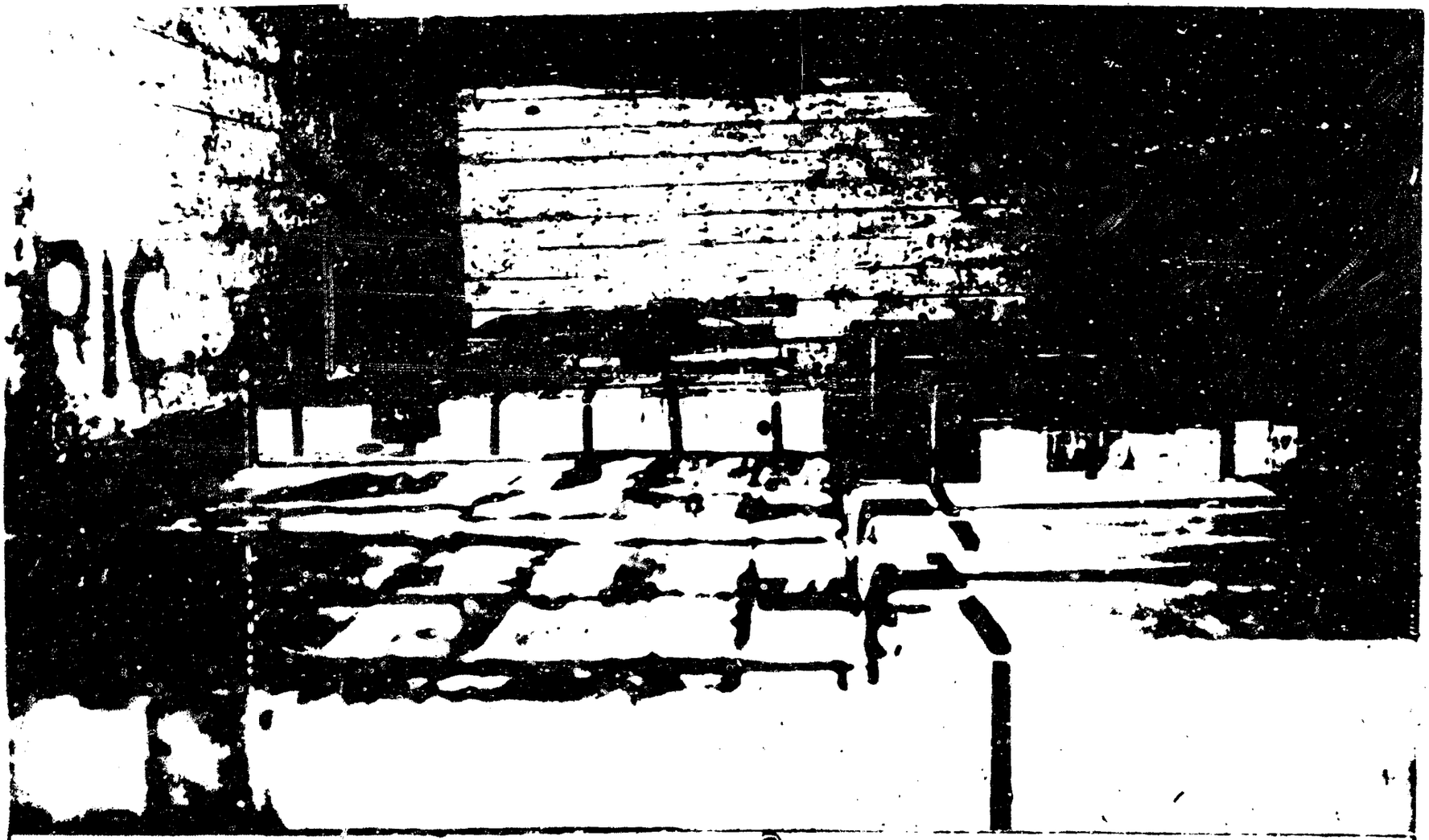
PALLET "D"- STEEL WIRE PALLET(EXPANDED METAL DECK) Condition of pallet-slightly damaged. Pallet was used for dragging on gravel road (see Test# 7, page #). Pallet bottom wires ground down to wire thickness of ".158- entire vertical assembly slightly inclined one way parallel to 3" wide metal bottom plates of pallet.

PALLET "E"- STEEL WIRE PALLET(EXPANDED METAL DECK) Condition fair. Pallet bottom structure curved slightly upward. Pallet was used in Test # 7- Towing Test (see page #).

PALLET "F"- STEEL WIRE PALLET(FIBREBOARD DECK) Condition fair. Deck was ruptured in Test # 6 Shock Loading Test (see page #).

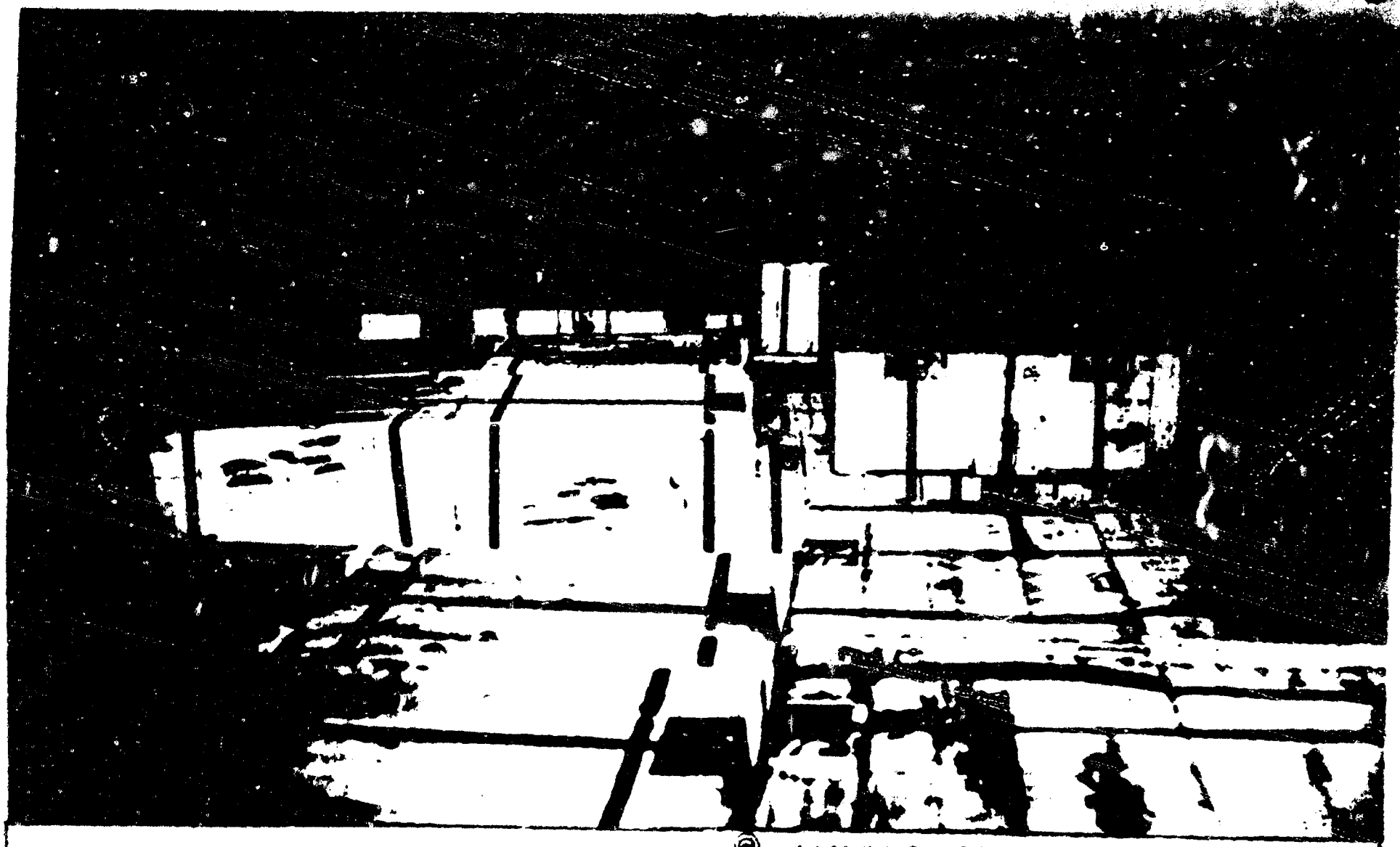
PALLET "G"- STEEL WIRE PALLET(FIBREBOARD DECK) Condition fair. Deck was cracked previous to test.

PALLET "H"- STANDARD NAVY WOOD PALLET Condition good. Pallet was used in Depot work.



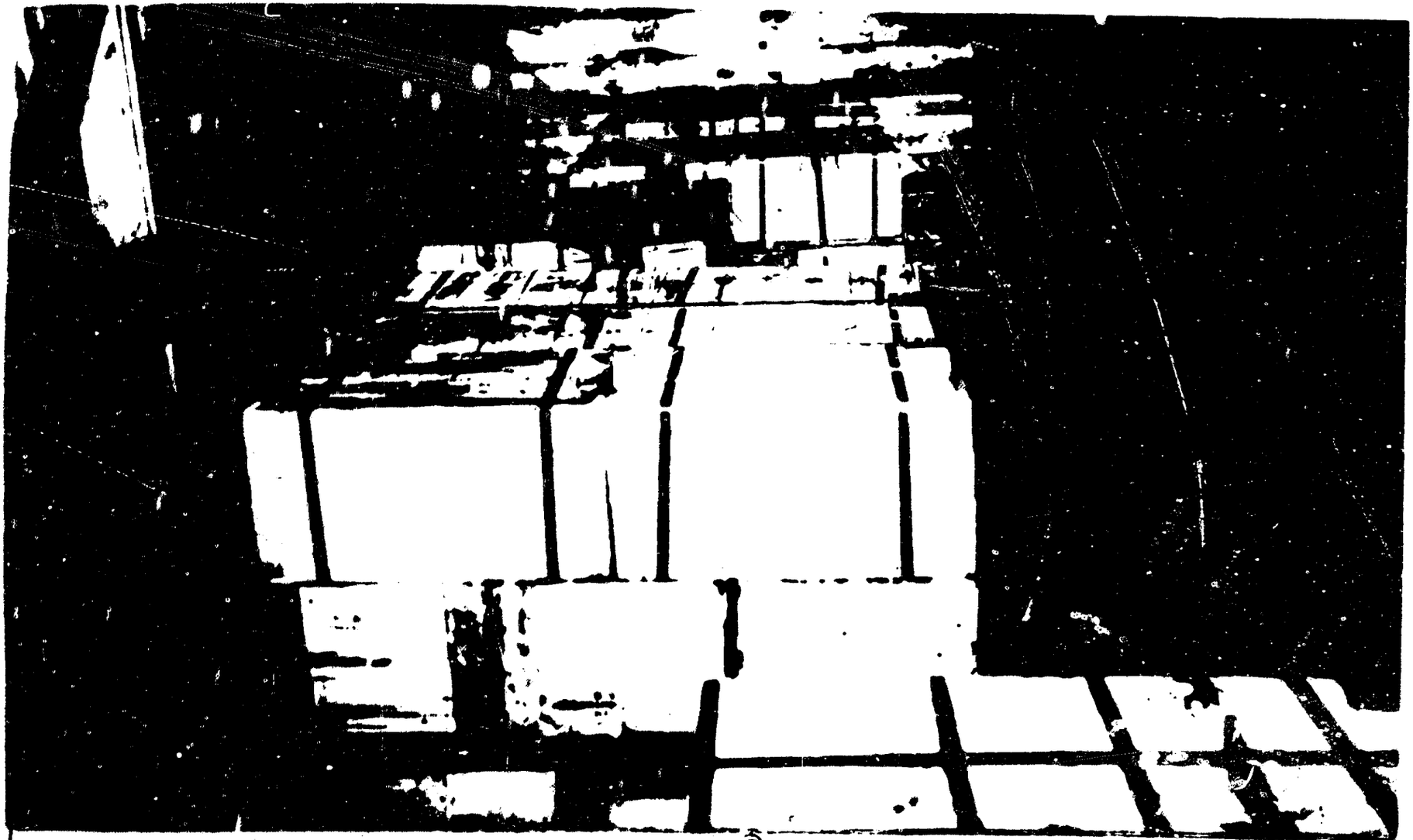
LOOKING TOWARDS "B" END INSIDE OF CAR #232886
PRIOR TO FREIGHT DUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-48 PAGE 153



LOOKING TOWARDS "A" END INSIDE OF CAR #232886
PRIOR TO FREIGHT HUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-47 PAGE 154



LOOKING TOWARDS "B" END INSIDE OF CAR#232876
PRIOR TO FREIGHT BUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-65 PAGE 153

LOOKING TOWARDS "A" END INSIDE OF CAR#232876
PRIOR TO FREIGHT BUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-46

LOOKING TOWARDS "F" END INSIDE OF CAR# 232662
PRIOR TO FREIGHT BUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-44 PAGE 157

the bending of the longitudinal bearing wires. Shift of load cracked "A" end of test car as per Photo 67-49, Page 159 .

3rd Impact

Car #232886 Speed 8.3 mph "A" end struck.

Observations

Pallet shift caused a disarranged condition of pallet loads around doorway area shown by Photo 67-57, Page 160 .

4th Impact

Car #232867 Speed 10.8 mph "A" end struck.

Observations

Total shift of "B" end towards "A" end. Pallet "D" flattened completely at vertical posts shown by Photo 67-51, Page 161. Pallet "F" collapsed at front end shown by Photo 67-52, Page 162 . The understructure of Pallet "E" was bent.

5th Impact

Car #232882 Speed 10 mph "A" end struck.

Observations

Further general compression of pallet loads.

6th Impact

Car #232866 Speed 8 mph "B" end struck.

Observations

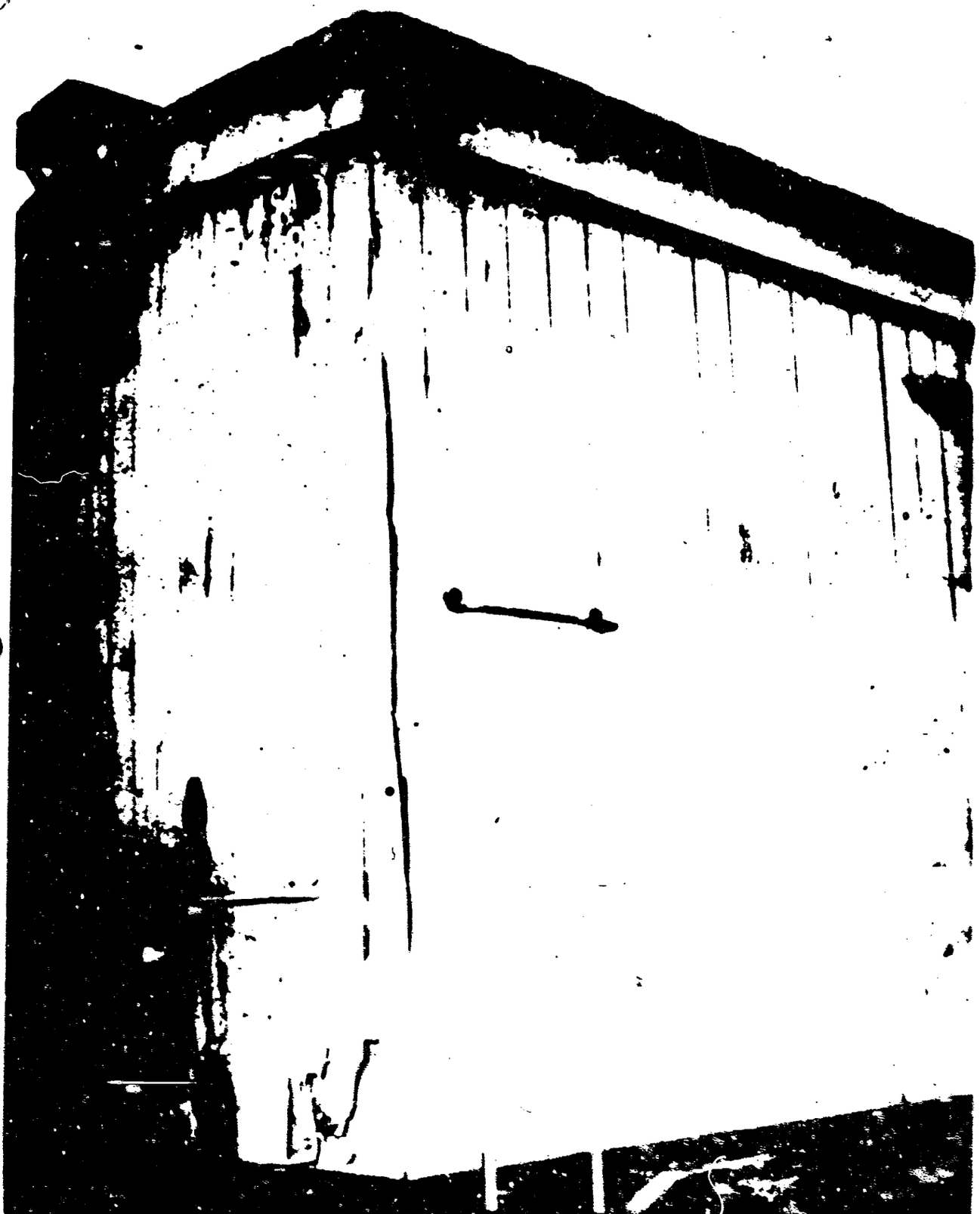
Total shift of pallets from "A" end to "B" end.

7th Impact

Car #232885 Speed - 7 mph "B" end struck.

Observations

"B" end of car cracked through at floor level due to pallet impacts.



DAMAGE TO "A" END OF CAR# - 232886 AFTER SECOND IMPACT. SPEED WAS 6.2 M.P.H. WITH "A" END STRUCK. DAMAGE CAUSED BY LOADED PALLETS HITTING END OF OBSOLETE CAR.

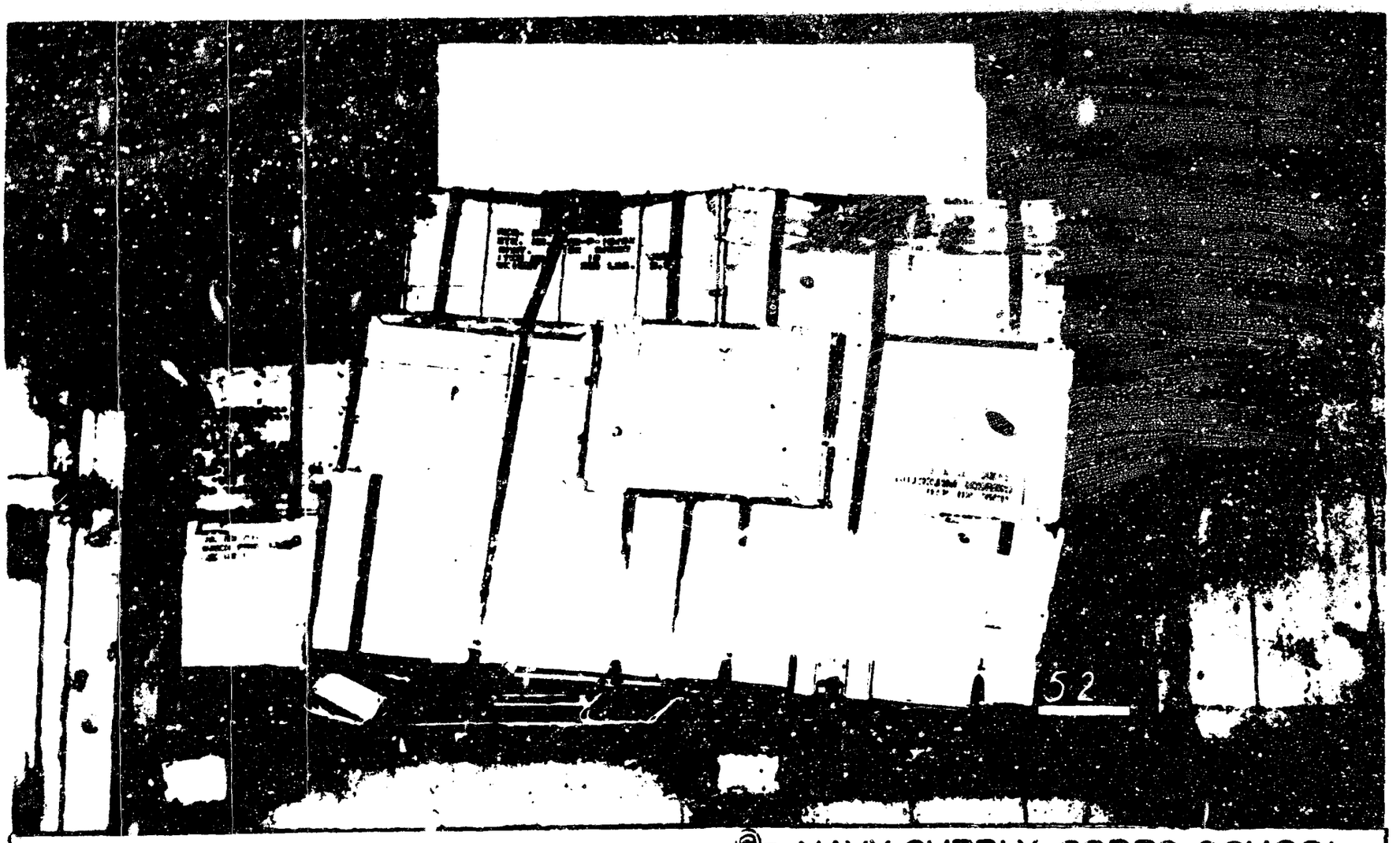
NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE
PROJECT SERIAL NO. T-003-010
PHOTO NEG NO 67-49
PAGE 19

DAMAGE TO DOORWAY OF CAR #232886 FOLLOWING THIRD IMPACT AT SPEED OF 8.3 M.P.H. DAMAGE CAUSED BY DISARRANGEMENT OF UNBRACED LOADED PALLETS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-57 PAGE 160

RESULTS OF SECOND IMPACT WITH CAR#232676 FOLLOWING SPEED OF 10.8 M.P.H. FOR FREIGHT HUMPING TEST. EXPANDED METAL DECK PALLET "L" DAMAGED BY COLLAPSE OF VERTICAL STRINGERS.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-51
PAGE 161



RESULTS OF SECOND IMPACT WITH CAR#232876 SHOWING FIBREBOARD DECK PALLET "F" AT DOORWAY AREA. SPEED WAS 10.8 M.P.H. FOR FREIGHT HUMPING TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67.52

8th Impact

Car #232875 Speed 8.6 mph "B" end struck.

Observations

Total shift of pallets in "A" end towards "B" end.

9th Impact

Car #232376 Speed 9.2 mph "B" end struck.

Observations

Further shift of pallets in "A" end towards "B" end. Two wood pallets overturned.

10th Impact

Car #232882 Speed 8.1 mph "B" end struck.

Observations

Total shift of pallets from "A" end towards "B" end.

11th Impact

Car #232882 speed 10 mph "B" end struck.

Observations

Further general compression of pallet loads causing disarranged load conditions as indicated by Photo 67-54, Page 164.

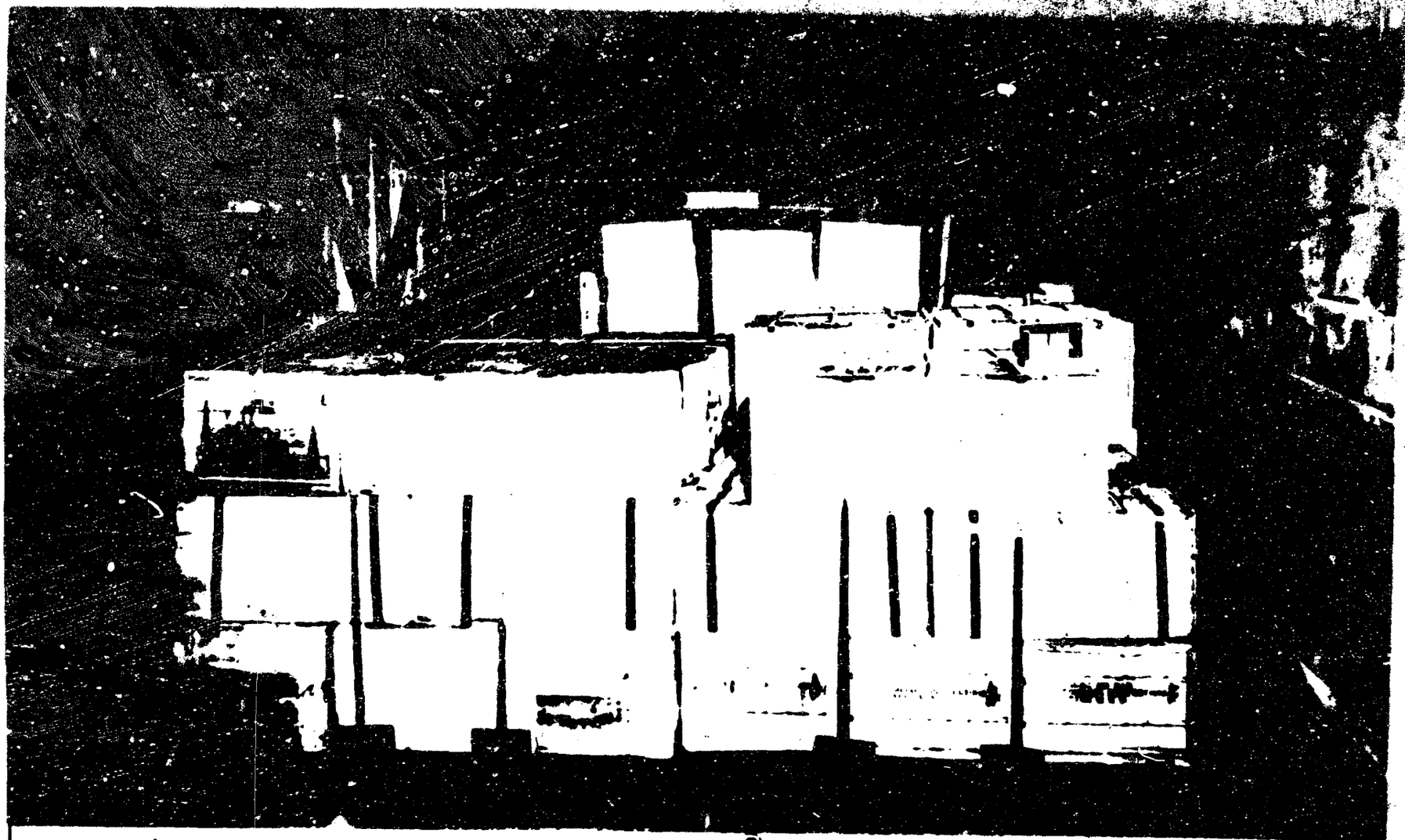
When the pallets were unloaded at the completion of the humping operations the following conditions were noted:

(a) Pallet "D" (Steel Wire Pallet - Expanded Metal Deck) had completely flattened out due to bending of the vertical "U" shaped wire supports as indicated by Photo 67-56, Page 165.

(b) Pallet "F", Photo 67-67, Page 166 and Pallet "G", Photo 67-66 Page 167 both of which were Fibreboard Deck Pallets were found in a state of complete deck breakdown. Pallet "G" also showed complete collapse of the vertical wire supports of one corner of the pallet.

Pallets "A" and "E" were found to be reasonably intact except for the bending of the understructure bearing supports.

Pallet "B" showed a general cracked deck condition and a slight bending of the understructure.



CONDITION OF INSIDE OF CAR#232882 FOLLOWING FOURTH IMPACT FOR FREIGHT HUMPING SUITABILITY TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67-54

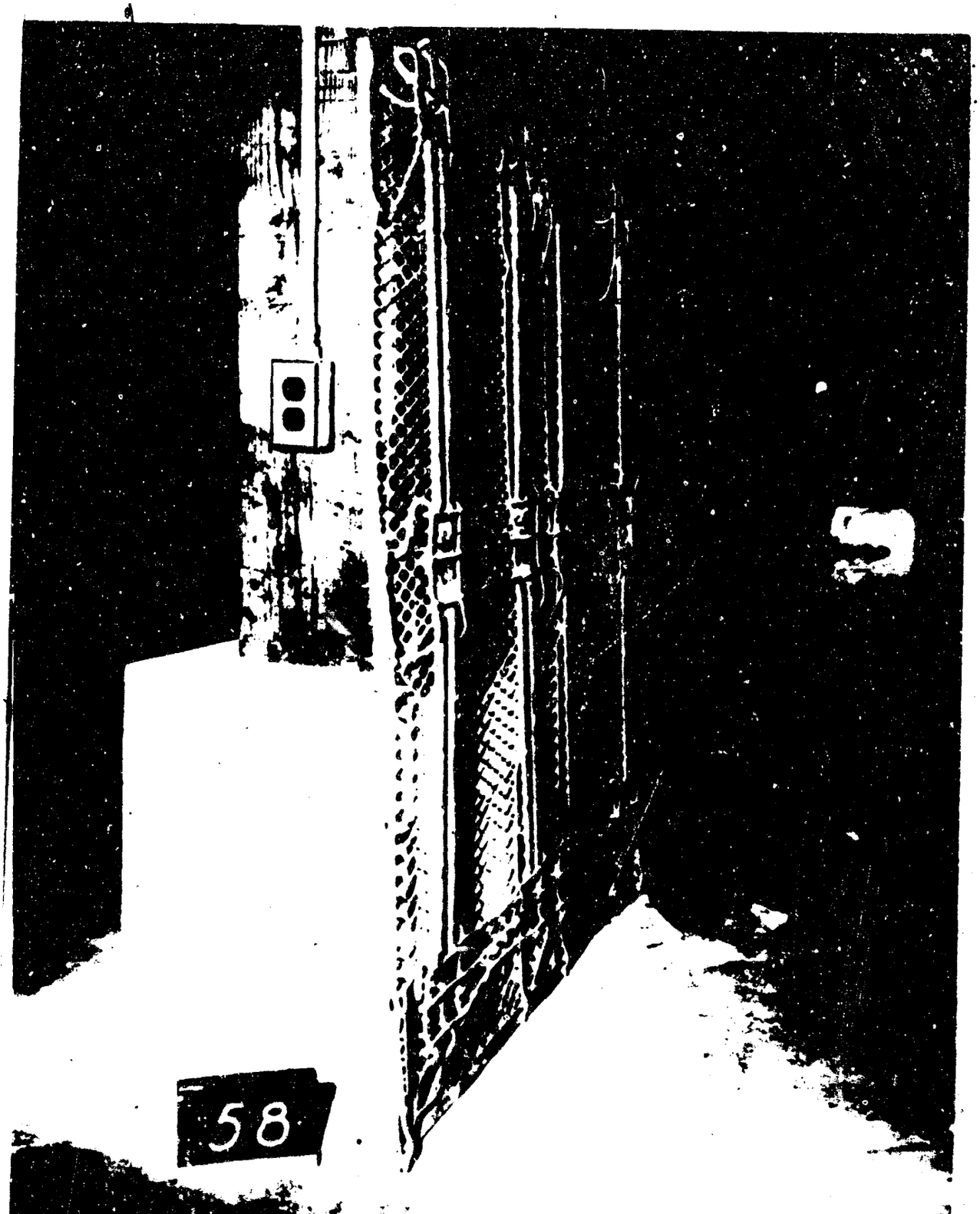


ILLUSTRATION OF RESULTS TO EXPANDED METAL DECK PALLET "D" IN FREIGHT BUMPING TEST. PALLET WAS DAMAGED SLIGHTLY PRIOR TO TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO 67-58 PAGE 165

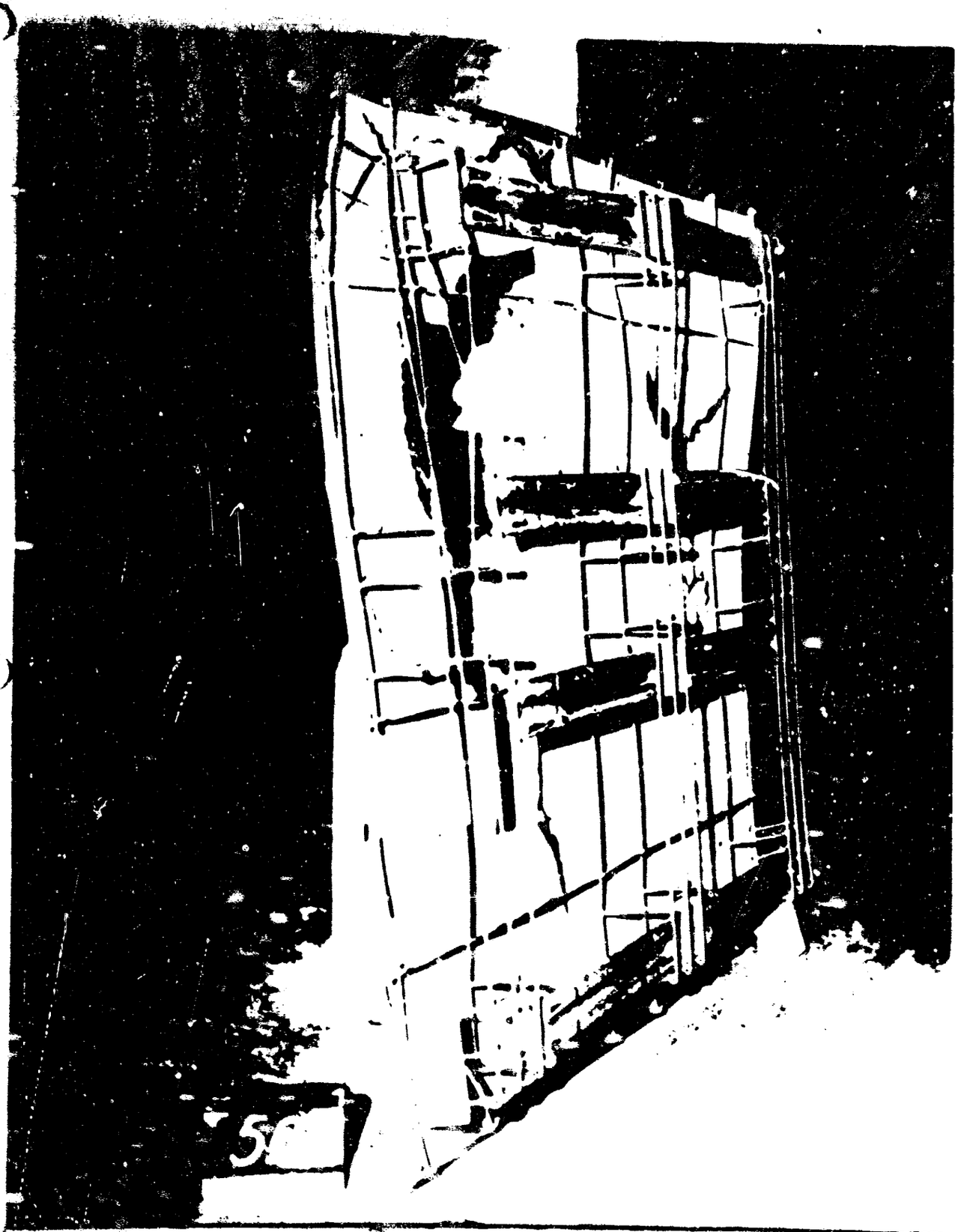


ILLUSTRATION OF RESULTS TO FIBREBOARD DECK PALLET "F" IN FREIGHT BUMPING TEST. DECK WAS SLIGHTLY DAMAGED PRIOR TO TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 57-47 PAGE 166

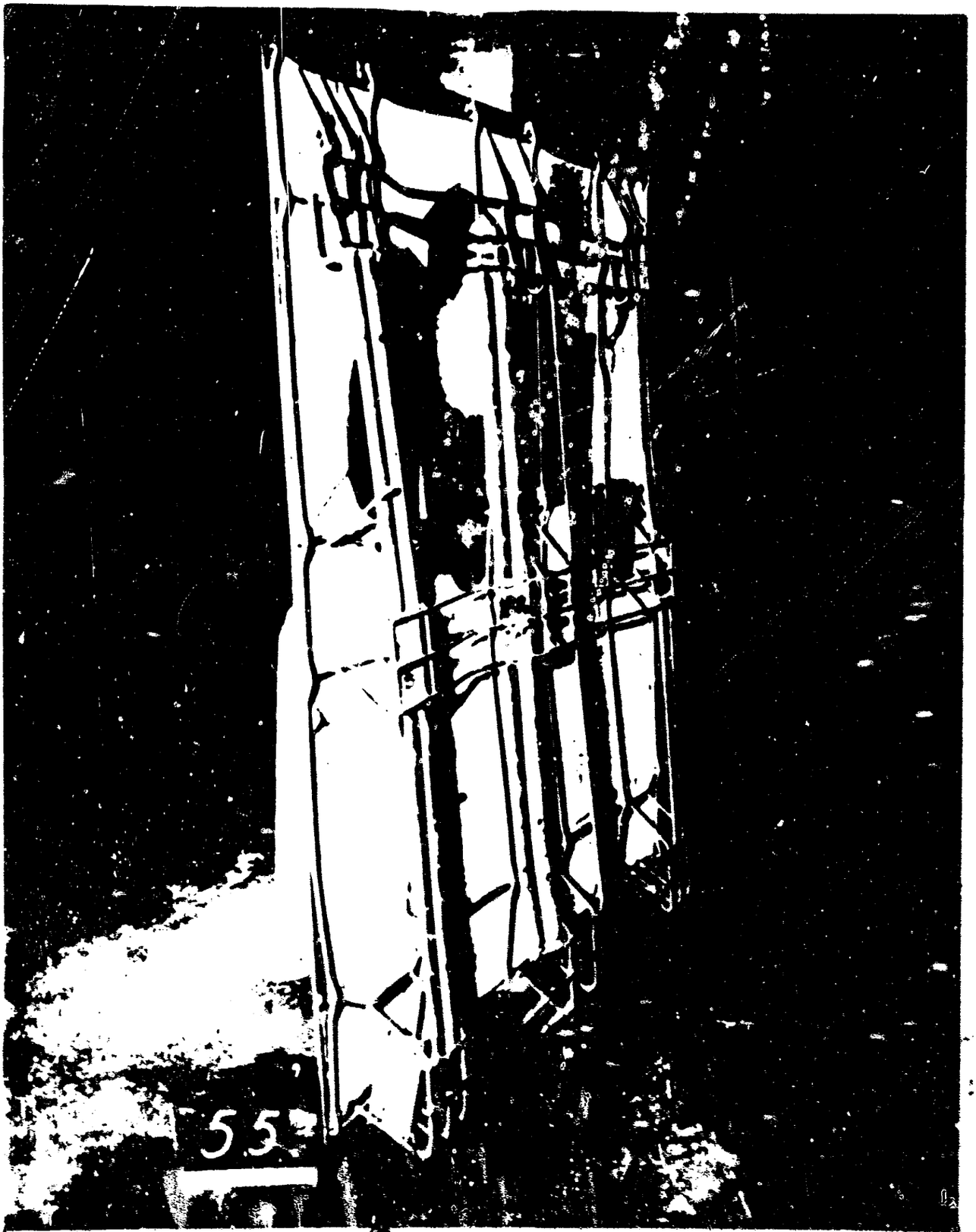


ILLUSTRATION OF RESULTS TO FIBREBOARD DECK PALLET "O" IN VERTICAL BUMPING TEST. DECK WAS SLIGHTLY CRACKED PRIOR TO TEST.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J
PROJECT SERIAL NO. NT-003-010
PHOTO NEG NO 67466 PAGE 167

The Standard Navy Wood Pallets "C" and "H" were found to be reasonably intact except for a cracked wing on one side of pallet "C". Both pallets showed a fine splintered condition where the steel strapping passed under the stringers of the pallet as indicated by Photo 67-65, Page 169 .

CONCLUSIONS

Results of the Freight Humping Test indicate that the Steel Wire Pallet (Expanded Metal Deck) and the Steel Wire Pallet (Fibreboard Deck) are not suitable for freight humping operations. Failures of the pallets have been due to structural instability of the vertical "U" shaped support wires when severe transverse strains are imparted to the understructure of the pallet. It is important to note that failures which have occurred with these pallets have happened when the 3" wide bottom plates were placed in the direction of the freight car travel. There are three contributing reasons for this. The first reason is that the vertical posts of the pallet have a greater dimension in one direction than in the other. The "U" shaped vertical posts are located under the pallet parallel to the 3" wide metal plate and in this direction the span of the vertical supports of the pallet is governed by the 5⅛" width of the "U" shaped wire posts. At 90° to this position the sides of two of the "U" shaped posts with an additional "L" shaped wire support (placed only at the pallet corners) form one of the nine units providing hei ht supports for the pallet. In this direction the span of the vertical wire supports is only 2" thereby providing greater rigidity of the corner posts in the 2" direction than in the 5⅛" direction. The second reason is that the outside lower wires on the pallet in a direction 90° to the direction of the 3" wide bottom plates are bent over approximately 3½" to form a brace for each of the corner

ILLUSTRATION OF DAMAGE TO STANDARD NAVY WOOD PALLET IN FREIGHT HANDLING TEST. DAMAGE TO VERTICAL STRINGERS WAS CAUSED BY STEEL STRAP.

NAVY SUPPLY CORPS SCHOOL
TEST & DEVELOPMENT DEPT.
BAYONNE N.J.
PROJECT SERIAL NO. NT-003-010
PHOTO NEG. NO. 67-63 PAGE 169

posts. Such bracing is not secured in the direction parallel to the 3" wide bottom plates and the pallet is therefore weaker in that direction. The third reason is that the method of joining the legs of the "U" shaped vertical posts to the top of the pallet is such that the legs are weaker in a direction parallel to the 3" wide bottom plates.

Failures of these pallets in other tests of the Standard Test Procedure have confirmed the fact that the pallets are weaker in a direction parallel to the 3" wide bearing plates than in a direction 90° to such bearing plates.

The Navy Standard Wood Pallets tested in this freight humping test to provide comparative results indicated very minor damage at the conclusion of the test.

The Steel Wire Pallet (Fibreboard Deck) was found to be lacking in strength of the top deck. The deck did not reinforce the bottom structure and proved brittle and easily damaged. Such pallet is not acceptable for this test.

The Steel Wire Pallet (Rolled Expanded Metal Deck) was found to be not acceptable for this test in its present design but could be improved by reinforcement of the vertical posts of the pallet. If sufficient reinforcement is provided in each direction it is believed this pallet would meet the requirements of this test.

TEST #26 - PALLET ADAPTABILITY

STANDARD TEST PROCEDURE

Under combat conditions pallets are sometimes called upon to perform other functions after completion of their primary use of moving and storing supplies. Such extra use may consist of being applied as hospital floors, tent floors, defense barricades, shoring, sleds, etc.

Adaptability for such extra use may be of importance in the determination of a pallet for specialized functions under emergency conditions and this test will report on the possible adaptability of each pallet.

TEST CONDITIONS

Each type of pallet construction was observed for possible useful applications after the pallet had served its normal requirements of handling cargo. A material list of components was studied for possible utilization of the individual parts of the pallet structure as a source of stock for various improvised construction purposes.

RESULTS

Both types of pallets are of a welded construction which is not readily disassembled. As a unit, both pallets have limited possibilities for adaptation to other functions. Although improvised flooring, bracing, and shoring could be accomplished with the assembled pallet it is not as adaptable to the many extra duties for which a Standard Wood Pallet is. If the pallets were disassembled the metal material forming the structure could be utilized as a source of round and flat metal stock for incidental machine shop jobs such as studs, screws, pins, flat bands, steel edging, etc.

The decks of the pallets could be easily adapted to various construction purposes such as steel gratings, temporary partition

walls, landing mats, improvised roadways, and etc.

CONCLUSIONS

Both types of pallets are not as adaptable to extra duties once their primary purposes are accomplished, as are the Standard Navy Wood Pallets.

The component parts of the Steel Wire Pallets would serve in such cases primarily as a source of raw material which could be utilized in metal trade functions.

TEST #27 - BUOYANCY TEST

STANDARD TEST PROCEDURE

Test shall be conducted upon each pallet to determine if it will or will not float when placed in sea water.

The reason for this test is that in emergencies it may be necessary to jettison pallets into the sea after they have performed their primary function in the transportation of supplies. For security reasons it may be necessary that such pallets should immediately sink and leave no trace. Other instances may occur in which it may be advisable to have the pallets float. This test is designed to report upon such characteristics.

TEST CONDITIONS

One empty pallet of each type was secured by a 20' tie line and dropped from a bulkhead wall into sea water having a channel depth of approximately 30'. During this operation observations were directed to the effects of the buoyant force of sea water upon the pallet structure.

RESULTS

Both the Fibreboard Deck and the Rolled Expanded Mat Deck types of Steel Wire Pallets immediately sank, when dropped into sea water, to a depth limited by the length of the tie line.

CONCLUSIONS

Both types of pallets are recommended for operations in which, for security reasons, pallets should be able to rapidly sink in sea water. The sinkability displayed by these pallets is apparent in their design. The steel construction of these pallets does not permit flotation of the pallet in sea water.

TEST #25 - SPARKING TEST

STANDARD TEST PROCEDURE

Each pallet shall be tested to determine if its component parts have sparking characteristics, i.e., whether or not sparks can be struck from it when hit, or dragged upon stones, concrete, steel, etc.

The reason for this test is that some loads such as ammunition, gasoline, oil, powder, etc., may create fire and explosion hazards if carried or dragged upon pallets which might emit sparks under favorable conditions. This test is designed to indicate if such a characteristic is present in any component part of the pallet tested.

TEST CONDITIONS

An empty pallet of each type was subjected to abrasive action by using a conventional bench type grinding wheel. Different portions of the bottom and top surfaces of the pallet were placed against the rotating grinding wheels by lifting the pallet from the ground and guiding the pallet to make a light contact with the grinding wheel.

RESULTS

When parts of the pallets were placed against the grinding wheel it was observed that sparks could be struck from the pallet. This condition resulted for different parts of the pallets with the exception of the Fibreboard Deck of the one pallet which is constructed of wood fibr

CONCLUSIONS

Both pallets are of steel construction and are therefore subject to sparking when submitted to certain abrasive action. Such sparking woul occur when these pallets are dragged over a concrete or stone surface, or under other impact or abrasive action. The use of these pallets is not recommended under operating conditions where the existence of sparks would be dangerous.

TEST #29 - REASSEMBLY TEST

STANDARD TEST PROCEDURE

Each pallet shall be investigated as to whether or not it may be knocked down for shipping and later reassembly in order to conserve shipping space. In addition to making comments on each pallet as submitted, information is also desired as to the advisability of having component parts produced by the manufacturer but not having final assembly made until point of use. In particular designs such a procedure might prove practical whereas in other cases the reverse might prove true. This test is designed to give information which will be of value if shipment of considerable amounts of pallets are contemplated.

TEST CONDITIONS

A careful study was made of the assembly structure of each type of pallet in order to determine the principle component parts. These parts were analyzed to determine how they might best be manufactured, but not totally assembled, in order to conserve a maximum amount of shipping space. Observations were also made to determine the type of work and the amount of work necessary to assemble such pallets at the point of use after shipment.

RESULTS

Both types of pallets are classified as a "weldment assembly" and as such the component parts are ordinarily permanently welded at the point of manufacture. For assembly, each pallet may be considered to be composed of 3 main component parts. These parts are:

1. The complete upper deck of the pallet
2. The complete under deck of the pallet
3. The vertical stringer wires separating the upper deck from the lower deck of the pallet.

At the present time the vertical stringer wires are resistance welded to both the upper deck and lower deck of the pallet. The overall height of the assembled pallet is 4½" and the total shipping cube of this 48" x 48" pallet is 6.02 cu. ft. If the pallet is shipped unassembled but with the upper deck and lower deck fabricated completely and with the vertical stringer wires formed, but not welded, the overall height of the pallet is 1" and the shipping cube totals only 1.36 cu. ft. which is only 22.5% of the completely assembled pallet. If pallets are shipped in a knocked-down condition they must be assembled at the overseas destination and such assembly to be efficient would require the use of adequate assembly jigs and manual welders. Of the vertical stringer wires, there are 18 with a "U" shape and 4 with an "L" shape for each pallet. For fastening the vertical stringer wires to the top and bottom decks of the pallet a total of 106 one quarter inch lap welds are required for each pallet assembly. Using a conservative figure of one minute per weld and including set-up time, etc., it is estimated that it would require 2 hours and 15 minutes to assemble a pallet of this type which is received in a knocked down condition. Such assembly time would also be contingent upon special welding jigs and fixtures being furnished at the Port of Embarkation for use overseas, and is also dependent upon use of qualified welding personnel.

CONCLUSIONS

With both of these types of Steel Wire Pallets it would be most economical from a manufacturing standpoint alone, to completely assemble the pallets at the manufacturers plant where full advantage could be taken of time and labor saving machinery. After complete assembly it is not possible to disassemble these pallets.

If conditions exist where the saving of shipping space is more important than cost and time, then under such conditions it would be possible to make unassembled shipments in the manner which has been recommended. The success of unassembled shipments would depend considerably upon preliminary planning, and upon skilled welding labor and equipment necessary in the proper assembly at the point of use.

TEST #20 - UNIT COST

STANDARD TEST PROCEDURE

The cost of pallets in quantities from one to ten shall be listed in the pallet report in order to provide a basic cost comparison between the different pallets.

It is recognised that quantity prices may vary considerably from the quoted unit price and that such prices would be subject to submittal in regular government bid form for specific Navy purchases, however, it is believed that the indicated unit price will give a fair approximation to the basic cost of pallets for general purposes of comparison.

RESULTS

The prices for the Steel Wire Pallet (Rolled Expanded Metal Deck) and the Steel Wire Pallet (Fibreboard Deck) was determined as being twelve dollars each for each type, in lots of ten of each type, from Navy Purchase Order No. N7sx614(F) dated 17 January 1947 under which these pallets were obtained.

The price of a Standard Navy Wood Pallet is listed in the Standard Stock Catalogue as $2.30 each. Under present day prices, the catalogue price was considered low, and inquiries made as requested by Bureau of Supplies and Accounts letter to Supply Officer in Command, Navy Supply Corps School, File N41-2(SW-5)LAM:rbw, dated 23 September 1947, revealed present day commercial delivered prices to be approximately three dollars and ten cents per pallet. Such price for pallets made of wood can be expected to vary in accordance with current lumber prices. Price of such Standard Navy Wood Pallets were estimated to be $2.75, F.O.B. Mill, with 35 cents allowed in addition for delivery charges.

CONCLUSIONS

	Price
Steel Wire Pallet (Rolled Expanded Metal Deck)	$12.00 each
Steel Wire Pallet (Fibreboard Deck)	12.00 each
Navy Standard Wood Pallet	3.10 each